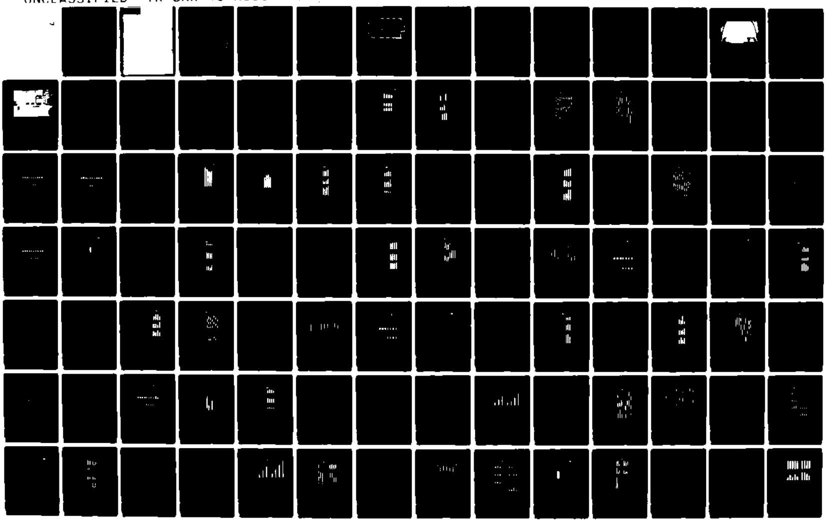
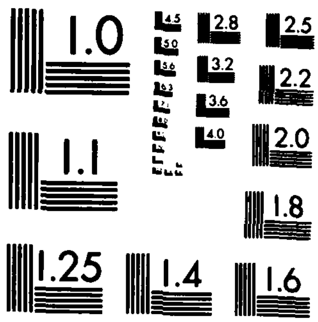
AD-A141 561 BEHAVIORAL AND BIOLOGICAL EFFECTS OF CHANGES IN GROUP SIZE AND MEMBERSHIP(U) JOHNS HOPKINS UNIV BALTIMORE MD DEPT OF PSYCHIATRY H H EMURIAN ET AL. 01 JUN 84 1/2

UNCLASSIFIED TR-ONR-10 N00014-80-C-0467 F/G 5/10 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER TR-ONR-10	2. GOVT ACCESSION NO. AD-A141561	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Behavioral and biological effects of changes in group size and membership		5. TYPE OF REPORT & PERIOD COVERED Technical Report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Henry H. Emurian, Joseph V. Brady, R. L. Ray, James L. Meyerhoff, and Edward H. Mougey		8. CONTRACT OR GRANT NUMBER(s) N00014-80-C-0467
9. PERFORMING ORGANIZATION NAME AND ADDRESS Department of Psychiatry The Johns Hopkins University School of Medicine		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS NR 170-910
11. CONTROLLING OFFICE NAME AND ADDRESS Organizational Effectiveness Research Programs Office of Naval Research (Code 452) Arlington, VA 22217		12. REPORT DATE 1 June 1984
		13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release, distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

This research was also supported by NASA Grant NGR 21-001-111

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Team turbulence, programmed environment, performance effectiveness, team task.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Groups performing complex tasks under operational conditions can be anticipated to undergo changes in size and membership. Accordingly, the present research project developed a paradigm for investigating effects of

such membership turbulence with 2-person and 3-person groups residing in a programmed laboratory environment for 10 successive days. A range of mission parameters (e.g., performance tasks, motivation, group gender composition, social interaction opportunities, etc.) was systematically explored during 10 studies that included 6 analyses of changes in group size and 4 analyses of changes in group membership. The resulting database provides the opportunity for inductive determinations of interrelationships among performance, behavioral, and endocrine effects that were assessed throughout each of the 10 group investigations.

Research analyses of small-scale human social systems have been limited historically by the practical difficulties (e.g., expense, effort, peer support, etc.) of conducting experiments to identify factors that may influence the status of group members (cf., Chiles, Alluisi, and Adams, 1968; Helmreich, 1971; Seitz, Goldman, Del Vacchio, Phillips, Jessup, and Fagin, 1970; Smith and Haythorn, 1972). Reviews and interpretations of the literature suggest that research on individual and group effectiveness under laboratory conditions would benefit from an effective methodology for long-term analyses of human social systems within the context of a comprehensive living and work setting (Thorndyke and Weiner, 1980; Hare, 1976). This Technical Report describes an experimental methodology produced in the course of developing a laboratory environment designed for the observation and measurement of human behavior in small groups over extended time periods (e.g., weeks), and it presents detailed results of 10 residential investigations of the behavioral and biological effects of introducing a novitiate participant into an established group and of replacing an established team member with a novitiate participant.

PROGRAMMED ENVIRONMENT

The residential laboratory consists of 5 rooms and an interconnecting corridor, and it was constructed within a wing of The Henry Phipps Psychiatric Clinic at The Johns Hopkins University School of Medicine. The floor plan of the laboratory and its position within the surrounding building shell are presented in Figure 1. Each private room (2.6 x 3.4 x 2.4 m) is similar to a small efficiency apartment containing kitchen, bathroom, bed, desk, etc. The recreation area (4.3 x 6.7 x 2.7 m)

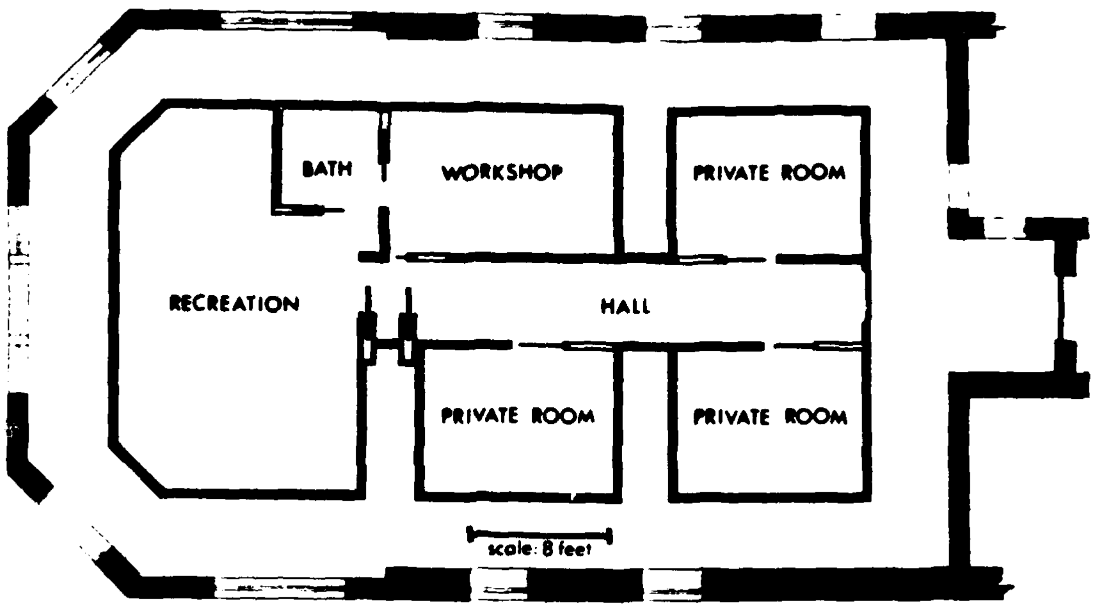


Figure 1. The floor plan of the laboratory and its position within the surrounding building shell.

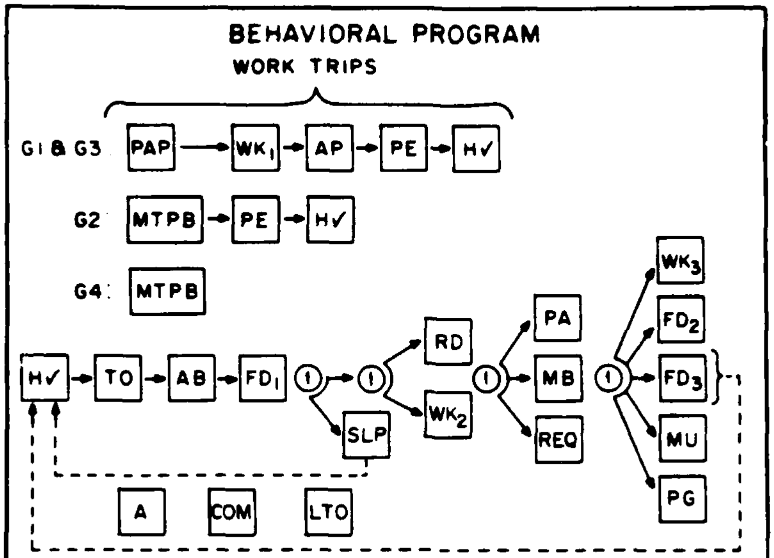
contains a complete kitchen facility along with exercise equipment and games. The workshop (2.6 x 4.1 x 2.7 m) contains operator consoles for individual and group performance tasks. A common bathroom serves the recreation and workshop areas. In summary, the programmed environment can accomodate at least three participants for intensive behavior analyses, and even more study subjects could be added to an experimental protocol by allowing additional members to reside temporarily within the recreation area along with their periodic rotations to the privacy of the individual rooms when solitary members move to the recreation area. Design drawings and photographs of the laboratory have been published elsewhere (Bigelow, Emurian, and Brady, 1975; Brady, Bigelow, Emurian, and Williams, 1975; Emurian, Brady, Ray, Meyerhoff, and Mougey, 1983; in press).

The laboratory is "programmed" in the sense that its resources are restricted by design features that regulate access to storage compartments or to areas containing supplies necessary to accomplish a given performance unit. Electro-mechanical control devices positioned throughout the environment are interfaced with computer systems located within adjoining laboratory support facilities that provide for monitoring, programming, recording, and data analysis. Audio and video equipment, located with the awareness of participants within each of the residential chambers, permits continuous monitoring during conduct of an experiment. Ample privacy exists, however, for personal hygiene and sleeping.

BEHAVIORAL PROGRAM

To structure the group members' use of the laboratory's resources in an orderly yet meaningful way, a behavioral program was developed to establish and maintain individual and group performance baselines as well as to provide the context for experimental manipulations of performance interactions during extended residential studies. A behavioral program is defined by (1) an array of activities or behavioral units and (2) the rules governing the relationships between these activities. Figure 2, for example, illustrates diagramatically (1) the fixed and optional activity sequences that characterize a typical behavioral program used to establish baseline performances and (2) an array or inventory of component activities that constitutes such a program. Each box within the diagram represents a distinct behavioral unit and performance requirement, with progression through the various activities programmed sequentially from left to right. The "Work Trip" is optionally available between any two adjacent activities within the program. All behavioral units are scheduled on a contingent basis such that access to a succeeding activity depends upon satisfaction of the requirements for the preceding unit. Details regarding the composition of the behavioral program and the methods for stimulus control of component activities are presented elsewhere (Emurian, Emurian, and Brady, 1978; Emurian, Emurian, Schmier, and Brady, 1979).

The behavioral program provides one promising approach to the problem of how to structure the resources available to a confined microsociety. The functional interdependencies among activities ensure that performances of value to the welfare of the individual (e.g., physical exercise), to the



INVENTORY OF ACTIVITIES

NOTATION	FULL NAME	BRIEF DESCRIPTION
PAP	PRIVATE ARITHMETIC PROBLEMS	150 CORRECT SOLUTIONS OF ARITHMETIC PROBLEMS
WK1	WORK ONE	5000 LEVER OPERATIONS
AP	ARITHMETIC PROBLEMS	50 CORRECT SOLUTIONS OF ARITHMETIC PROBLEMS
PE	PHYSICAL EXERCISE	500 CORRECT PRESSES ON AUTOMATED TASK
MTPB	MULTIPLE TASK PERFORMANCE BATTERY	G2: 600 CORRECT RESPONSES G4: NO RATIO
H✓	HEALTH CHECK	TEMPERATURE, PULSE, WEIGHT, STATUS REPORT
TO	TOILET OPERATIONS	USE OF PRIVATE BATHROOM AND CONTENTS OF DRAWER CONTAINING TOILETRIES
AB	AUTOGENIC BEHAVIOR	RELAXATION EXERCISES ON CASSETTE TAPE
FD1	FOOD ONE	TWO SELECTIONS FROM A LIST OF FOODS
SLP	SLEEP	USE OF BED AND PRIVACY CURTAIN
RD	READING	ACCESS TO BOOK
WK2	WORK TWO	PROBLEMS, EXPERIMENTS, ASSEMBLY PROJECTS
PA	PUZZLE ASSEMBLY	ASSEMBLE A PUZZLE
MB	MANUAL BEHAVIOR	ACCESS TO ART MATERIALS
REQ	REQUISITION	EARN DELAYED DELIVERY OF TREATS
WK3	WORK THREE	ACCESS TO WORKSHOP
FD2	FOOD TWO	PRIVATE MAJOR MEAL
FD3	FOOD THREE	MAJOR MEAL IN RECREATION ROOM, GAMES
MU	MUSIC	EARN A CASSETTE TAPE
PG	PRIVATE GAMES	ACCESS TO SOLITARY GAMES
A	AUDIT	RECEIVE WORK SCORES FOR ALL SUBJECTS
COM	COMMUNICATION	ACCESS TO INTERCOM
LTO	LIMITED TOILET OPERATIONS	ACCESS TO ESSENTIAL TOILET FACILITIES

Figure 2. A diagrammatic representation of (1) the fixed and optional activity sequences that characterize a typical behavioral program used to establish baseline performances and (2) an array or inventory of component activities that constitutes such a program.

welfare of the crew (e.g., social recreation), and to the welfare of a "mission" (e.g., sustained performance effectiveness) occur recurrently over time. These functional interdependencies reflect the "motivational" properties inherent within successive progressions through the program, and all incentives to maintain the day-by-day operational status of the microsociety can reside within the behavioral schedule itself, although superordinate objectives (e.g., money, adventure, and the promise of fame) clearly occasion participants' presence within such a setting. This proven technology has direct application to the problem of sustaining high levels of human performance and adaptation within confined habitats.

Not only does the behavioral program structure access to resources but it also makes available for measurement all corresponding activity units. The boundaries between successive activities in the program impose rigor on the assessment of individual and group preferences and effectiveness within those activities. Additionally, the program has the advantage of providing a comprehensive range of variables for observation and measurement. For example, at one level, a subject's performance on a complex task could be assessed (e.g., errors, response latency), and at another level, a subject's frequency and duration of progressions through the program could be assessed without regard to the intensive analysis of component activities composing such progressions. Moreover, the social status of the microsociety may be assessed by observing the degree of "synchrony" among subjects in the selection and completion of similar activities at the same time. Observations of subjects' communication networks along with the frequency, duration, and quality of dyadic and triadic social episodes

would complement synchrony measures. All these factors, then, contribute to a method having considerable and demonstrated power in the analysis of variables that impact upon individual and group performances, especially with regard to the potential interrelationships between the effectiveness of such performances and other contextual aspects encompassing the work environment.

Although performance effectiveness can be contingently related to access to other "high-value" activities in the behavioral program, a different incentive could be applied by relating performance effectiveness to compensation, and this has been the approach used for recent investigations in the laboratory. Thus, the intrinsic motivational properties of the behavioral program provide the context in which external incentives can be applied where a direct moment-to-moment relationship is desired between performance effectiveness (e.g., quality and quantity) and its immediate consequence. Such an interplay between incentives has been dramatically effective in (1) generating and sustaining complex human performances over extended time periods and in (2) providing the ancillary contextual observations that make performance changes interpretable in terms of a behavior analysis.

A Multiple Task Performance Battery (MTPB) served as the principal performance assessment tool throughout investigations conducted within the programmed environment. Figure 3 presents a photograph of the MTPB console on which the performance tasks were presented on a cathode ray tube (CRT) terminal. The battery were composed of the following 5 task components that were presented concurrently to an individual operator: (1)

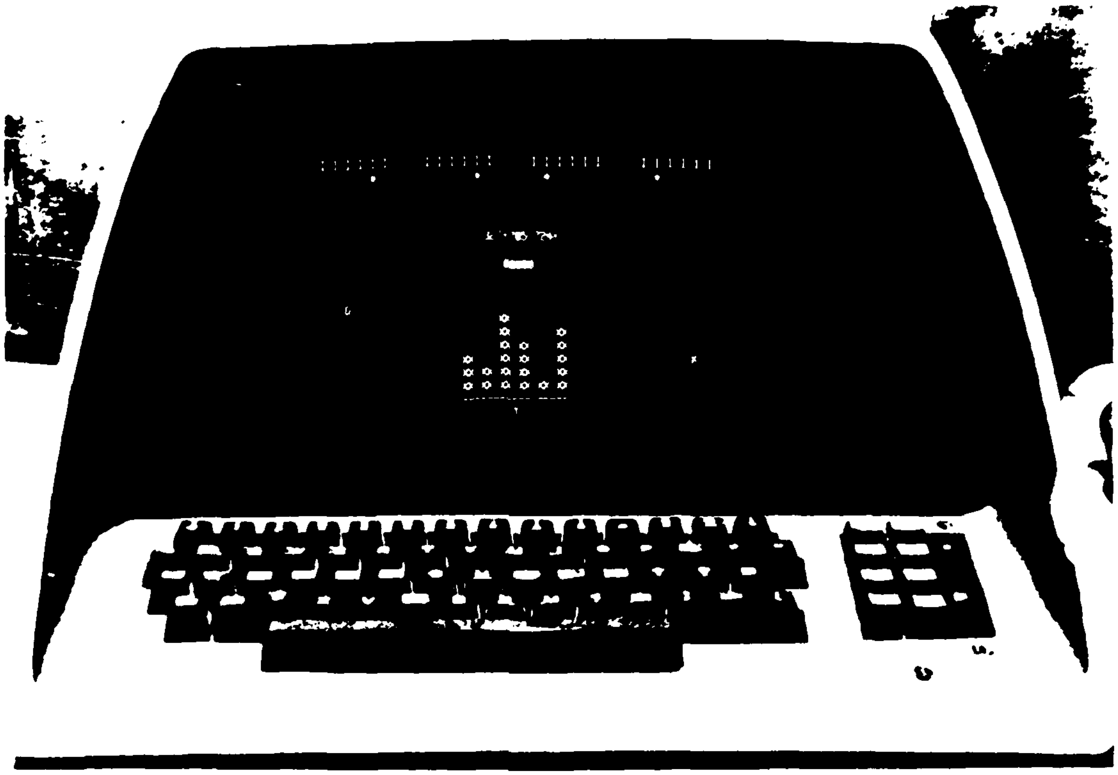


Figure 3. A photograph of the console on which the Multiple Task Performance Battery (MTPB) was presented.

oscillating lights, providing a measure of watchkeeping, (2) warning light monitoring, providing a measure of vigilance, (3) probability monitoring, providing a measure of attentive functions, (4) target identification, providing a measure of sensory-perceptual functions, and (5) mathematical operations, providing a measure of computational functions. A comprehensive description of the performance battery has been published by Emurian (1978), and a rationale for this "synthetic work" methodology has been provided by Morgan and Alluisi (1972).

The MTPB console was located within the workshop. When the individual MTPB was used, only 1 participant at a time was permitted access to the work station on a rotational basis determined by group members. When the team TMTPB was used, all 3 participants were required to enter and exit the work station together.

The MTPB is also available in a crew or team mode. The Team MTPB (TMTPB) involves three operator consoles, as presented in Figure 4, and each console presents the identical display of the 5 task components. The parameters of these tasks were modified to a difficulty level such that the concurrent inputs of 3 operators were required to avoid information overload and to produce maximum performance effectiveness per unit time. The "team" aspect of the task is reflected by the interlocking response demands associated with the probability monitoring subtask, and it was embedded within the context of the remaining 4 individually solvable subtasks. The team subtask requires the detection of a bias that is recurrently presented on any one or more of the 4 probability monitoring scales. Importantly, the operator inputs to the system to "correct" a bias

Figure 4. The configuration of the three operators' consoles for the Team Multiple Task Performance Battery (TMTPB).

required each of the three operators to press the corresponding "correct" keyboard character within 0.6 sec of the first such keyboard entry. Although correction of a bias produced increments in performance accuracy points, a team's failure to detect a bias resulted in subtractions to accumulated points. The team task, then, required (1) processing of symbolic informaton (i.e., the detection of a bias), (2) sharing information by communications among team members (e.g., One operator may say "Bias on one. Ready...Go."), (3) coordination of a response (i.e., 3 response inputs within 0.6 sec), and (4) sutained vigilance to avoid loss.

This team task represents the major performance dimensions considered to be critical to developing methods for quantitative analyses of the interrelationships between individual and team performance effectiveness, and it is a task exemplar for the analysis of circadian and biomedical aspects of crew workload interactions (Turney and Cohen, 1981). In this latter regard, the MTPB reliably elicits blood pressure responses in individual operators (Ray and Emurian, 1982a,b), and the sensitivity of skin temperature and skin conductance effects has previously been shown to be functionally related to individual MTPB workload conditions (Emurian and Brady, 1979).

INTRODUCTION EFFECTS

Previous investigations conducted under this Contract clearly established social behaviors as indices of the status of a confined microsociety, and they emphasized the sensitivity of social behavior to a range of experimental manipulations having operational significance.

Throughout such studies, mission participants were observed to seek social interaction under one set of conditions (e.g., cooperation contingencies and appetitive performance outcomes) and to withdraw from such interaction under other conditions (e.g., pairing contingencies and avoidance performance outcomes). Thus, the joining and leaving of a group by mission participants under circumstances encompassing more than a single environmental condition appeared to generate social effects reflecting important dynamic processes requiring experimental analysis.

Six studies were conducted to assess the effects on individual and group behavior of a novitiate participant's introduction into and subsequent withdrawal from a previously established 2-person social system (Emurian, Brady, Meyerhoff, and Mougey, 1981). The objectives of these fact-finding studies were to assess (1) the social mechanisms and temporal properties associated with the integration of such a participant into an established group and (2) sources of group disruption and/or cohesiveness fostered by the presence of a novitiate. In addition, measures of hormonal levels based upon the collection of total urine volumes throughout the course of the studies focused upon changes in the androgen testosterone as an endocrinological index of demonstrated sensitivity to social interaction effects in both animals (Eberhart, Keverne, and Meller, 1980; Bernstein, Rose, Gordon, and Grady, 1979) and humans (Scaramella and Brown, 1978). Such a behavioral biological analysis was implemented to provide a comprehensive assessment of the individual and social impact generated by the introduction and withdrawal of new members with an established group (Frankenhauser, 1979).

Subjects

Thirty-two subjects were accepted for participation on the basis of psychological evaluation, educational background, and availability. Two subjects participated in more than 1 experiment. The mean age of a subject was 28.41 years (SD=5.20), with a range between 18 and 39 years. No subject showed problematical issues or disruptive dispositions as evidenced by the results of the Minnesota Multiphasic Personality Inventory and the 16 Personality Factors Inventory, respectively. Subjects were fully informed about procedures, and they were familiarized with the laboratory during orientation and training sessions that preceded an experiment. There were no elements of deception involved in the research, and informed constant was obtained. Unless otherwise noted, groups were composed of male participants.

Urinary testosterone levels were determined by radioimmunoassay. Following a 72-hr hydrolysis with beta glucuronidase, the samples were extracted with methylene chloride. The methylene chloride layer was washed with water and dilute sodium hydroxide, and then it was evaporated. The extracts were purified on LH-20 Sephadex columns. Recoveries through the procedure were monitored by the addition of a small amount of tritiated testosterone added to each sample prior to extraction. The Sephadex column eluates were evaporated and taken up in RIA buffer. Aliquots were incubated overnight at $4^{o}C$ with a testosterone antibody produced in rabbits. Free and antibody-bound hormones were separated using Somogyi reagents. Radio-activity measurements were made in a Beckman LS-250 counter. Samples were assayed in duplicate and corrected for recovery.

<u>Groups 1 and 2: Introduction and Withdrawal of a Novitiate</u>

In the first two 10-day experiments, an initial baseline was established by having 2 participants follow a behavioral program while residing in the programmed laboratory environment for several successive days. Remuneration was a function of performance productivity on the MTPB. Accurate individual operation of the MTPB produced points that were deposited in a joint account to be divided evenly between the two 10-day participants at the conclusion of the experiment. A daily ceiling of 6000 accuracy points, representing approximately 12-16 hours of total work, was in effect for G1, whereas no ceiling was imposed for G2. Access to the social areas was programmed as a group activity, requiring all group members to select the activity concurrently.

For G1, social activities were optional, and their occurrence was unrelated to remuneration. For G2, however, social activities were also optional, but 1 social activity was required on each day of the experiment in order for group members to receive payment for that day's work. During a 2-person day, a dyadic activity was required, and during a 3-person day, a triadic activity was required. This contingency was imposed to permit a group member to express "aggression" by withdrawing from a social exchange relationship, thereby denying payment to other participants (<u>cf</u>. Emurian, Emurian, and Brady, 1982).

After 3 successive days (Days 1-3) under dyadic conditions, the third (<u>i</u>.<u>e</u>., novitiate) participant was introduced into the programmed environment. For G1, the third participant was permitted to contribute to the other participants' MTPB accumulations, but he was remunerated on a per diem basis without regard to his performance productivity. For G2,

however, when the third participant was introduced as a group member, the contingency protocol stipulated that only _2_ of the 3 group members could work on a given day, and the other "off duty" participant would be remunerated based upon the average MTPB productivity of the 2 working participants.

After 4 successive days (Days 4-7) under triadic conditions in both groups, the novitiate participant was withdrawn from the programmed environment, and the study continued for 3 additional days (Days 8-10) with the original 2-person group.

The novitiate participants in both groups contributed to MTPB point accumulations despite the fact that neither of them was required to perform such work. These data are shown in _Figures 5 and 6_ that present total performance points for all subjects in G1 and G2, respectively, across successive days of the experiment. The novitiate participant is identified as "S3."

In G1, the novitiate worked on all of Days 4-7 when he was a group participant. Although the novitiate never contributed more than 33.3% of the total daily point accumulations, it is notable that his work contribution was substantial even on Day 4, the first day of the triadic condition. All group members in G1 worked during Days 4-7. Despite a reduction in daily work exhibited by the two 10-day participants during Days 4-7, no participant "rested" by refraining from work.

In G2, the two 10-day participants refused to allow the "untested" novitiate to work on Day 4, the first triadic day of the study, despite

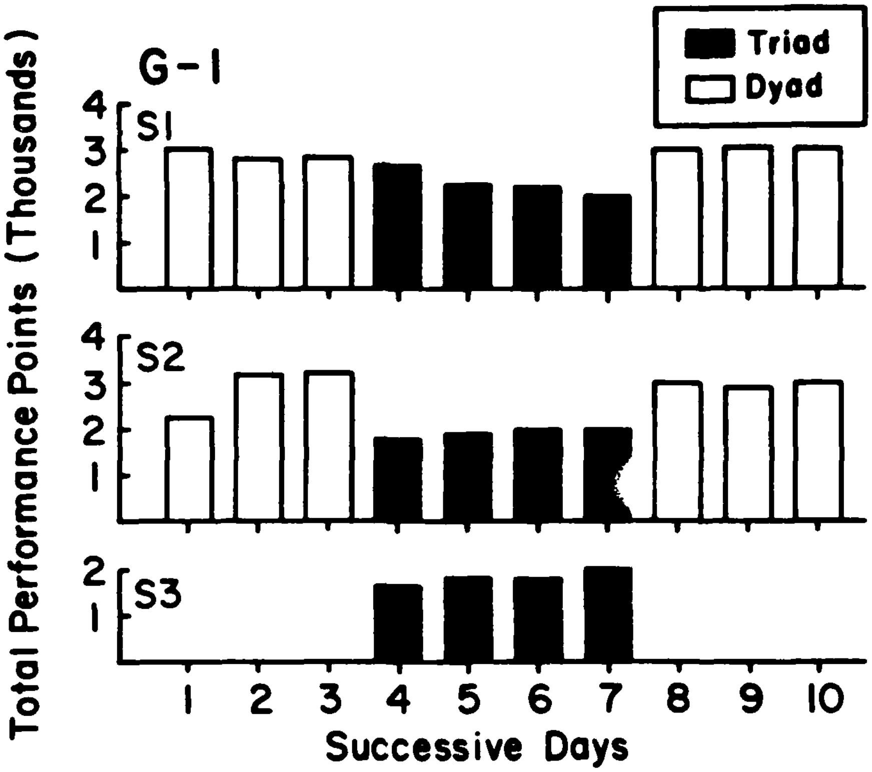


Figure 5. Total performance points for all subjects in G1 across successive days of the experiment. The novitiate participant is identified as "S3."

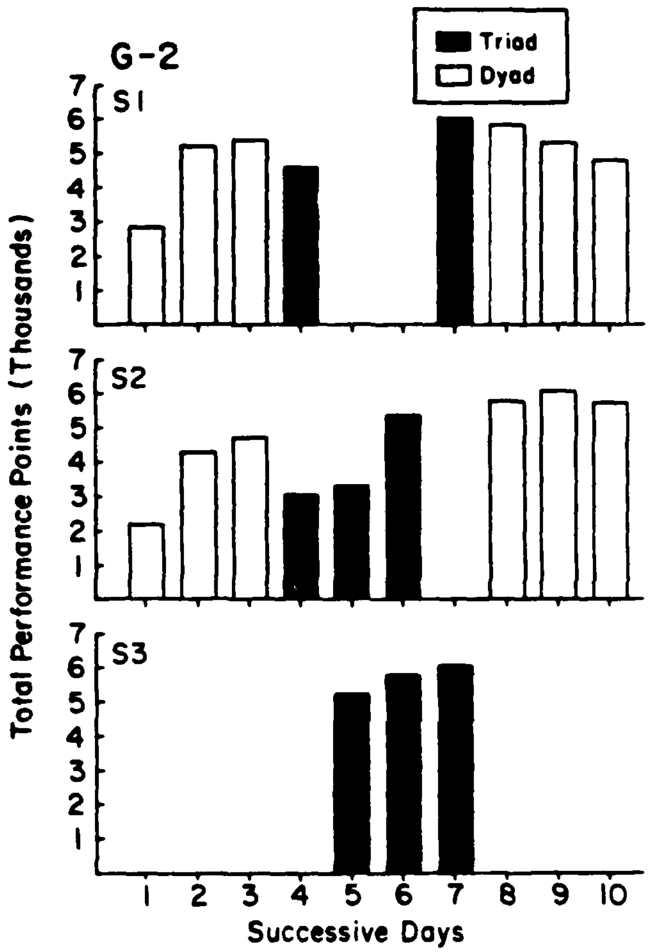


Figure 6. Total performance points for all subjects in G2 across successive days of the experiment. The novitiate participant is identified as "S3."

that participant's repeated exhortations to be granted permission to work. During the triadic condition, S1 rested on 2 of the 4 days (i.e., Days 5 and 6), and S2 rested on 1 of the 4 days (i.e., Day 7). When the novitiate participant was permitted to work on Days 5-7, he demonstrated daily work productivity almost equivalent to the highest levels observed by S1 and S2.

These data show the influence of social processes alone in maintaining performance by the novitiate, since in neither G1 nor G2 was that participant required to work for remuneration.

Figure 7 presents time of day spent working for all subjects within G1 across successive days of the experiment. A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show work periods that persisted across the boundary between successive days. Bracketed Days 4-7 were 3-person days. Subjects adopted an alterating pattern of work that differed within and among subjects across successive days. Work periods were typically brief, and they ranged in duration from less than 1 hr (e.g., S2, Day 2) to over 2 hours (e.g., S1, Day 10). When the novitiate, S3, was introduced on Day 4, he showed several brief daily work periods during Days 4-6, but he also showed the longest uninterrupted work period on Day 7, in comparison to other subjects' work periods on all remaining days.

Figure 8 presents time of day spent working for all subjects in G2 across successive days of the experiment. A "day" is bound by arrows on the ordinate, and the ordinate was exteded downward to show sleep periods that persisted across the boundary between successive days. Bracketed Days

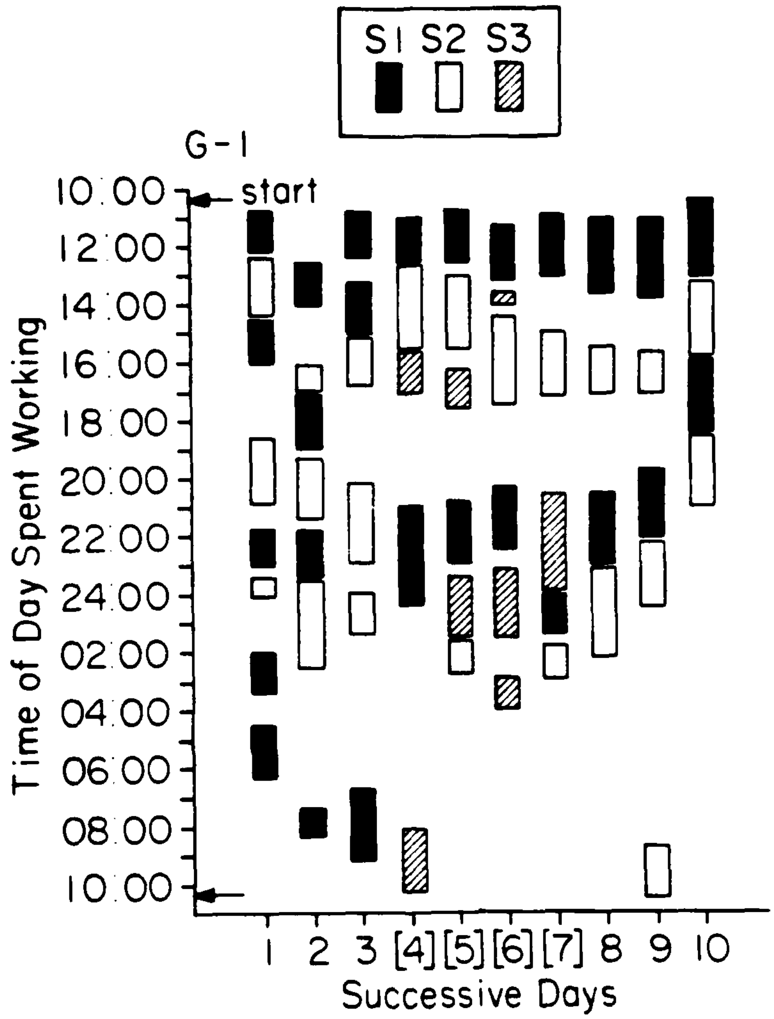


Figure 7. Time of day spent working for all subjects in G1 across successive days of the experiment. A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show work periods that persisted across the boundary between successive days. Bracketed Days 4-7 were 3-person days.

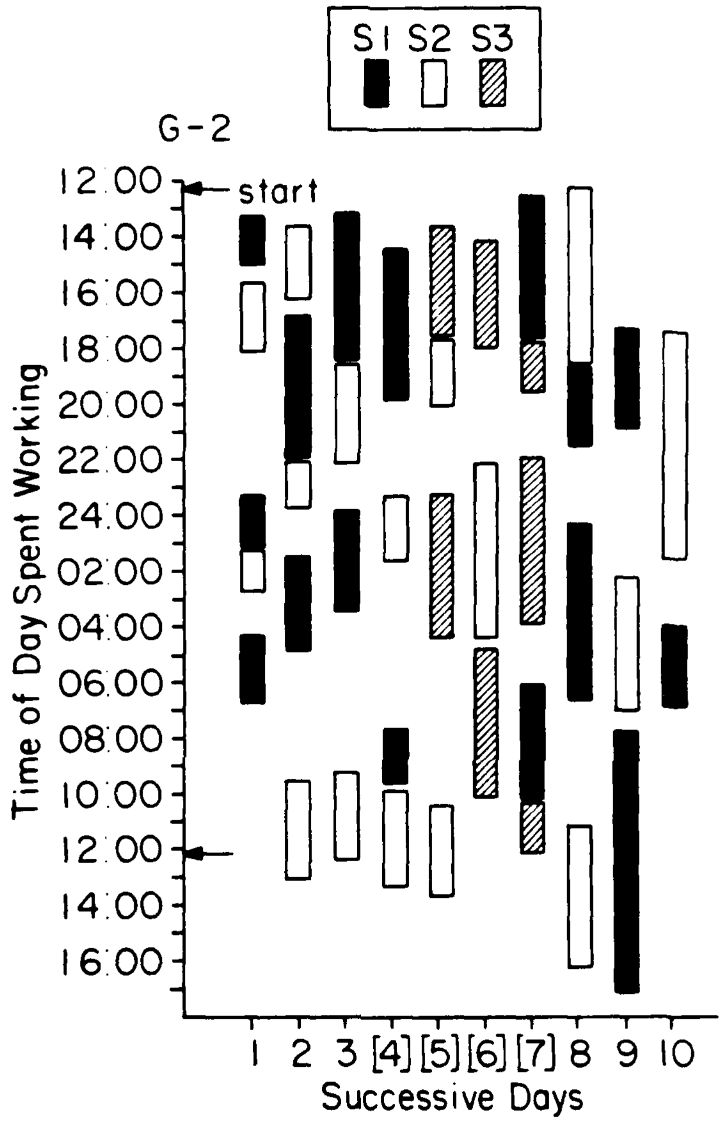


Figure 8. Time of day spent working for all subjects in G2 across successive days of the experiment. A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show work periods that persisted across the boundary between successive days. Bracketed Days 4-7 were 3-person days.

4-7 were 3-person days. As in G1, subjects within G2 adopted an alternating pattern of work that differed within and among subjects across successive days. Work periods ranged in duration from less than 2 hours (e.g., S2, Day 1) to over 9 nine hours (e.g., S1, Day 9). When the novitiate participant was granted permission to work on Days 5-7, his work capacity, as evidenced by sustained work periods, was not notably different from the other 2 participants. These observations suggest a significant resistance by an ongoing group to change an established and proven pattern of work to accomodate an "untested" novitiate when the situation did not permit immediate compensatory efforts by both 2-person members.

Figures 9 and 10 present time of day spent sleeping for all subjects within G1 and G2, respectively, across successive days of the experiments. For subjects in G1, sleep periods typically began after 2000 hours, and they were typically at least 8 hours in duration. Sleep onset time changed across successive days for established and novitiate participants. For subjects in G2, sleep periods typically began after 2400 hours. Sleep periods for subjects within G2 were graphically more erratic than for subjects within G1. Sleep periods were not demonstably affected by the introduction and withdrawal of a novitiate.

During each Health Check activity, each subject rated the other participant(s) on a 4-point scale where 1 = not bothered by a subject and 4 = extremely bothered by a subject. These scale anchors also apply to rating data presented below. Figures 11 and 12 present mean interpersonal ratings for all subject pairs in G1 and G2, respectively, across successive days of the experiment. The data are notable for the absence of negative

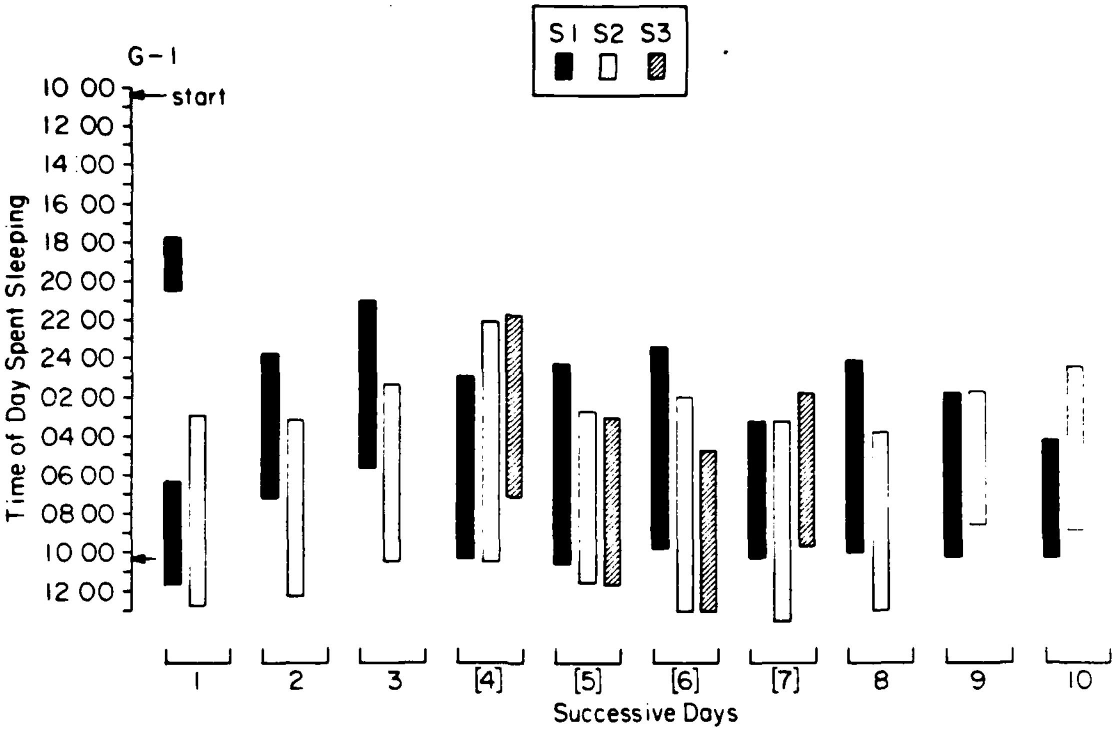


Figure 9. Time of day spent sleeping for all subjects in G1 across successive days of the experiment. A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show sleep periods that persisted across the boundary between successive days. Bracketed Days 4-7 were 3-person days.

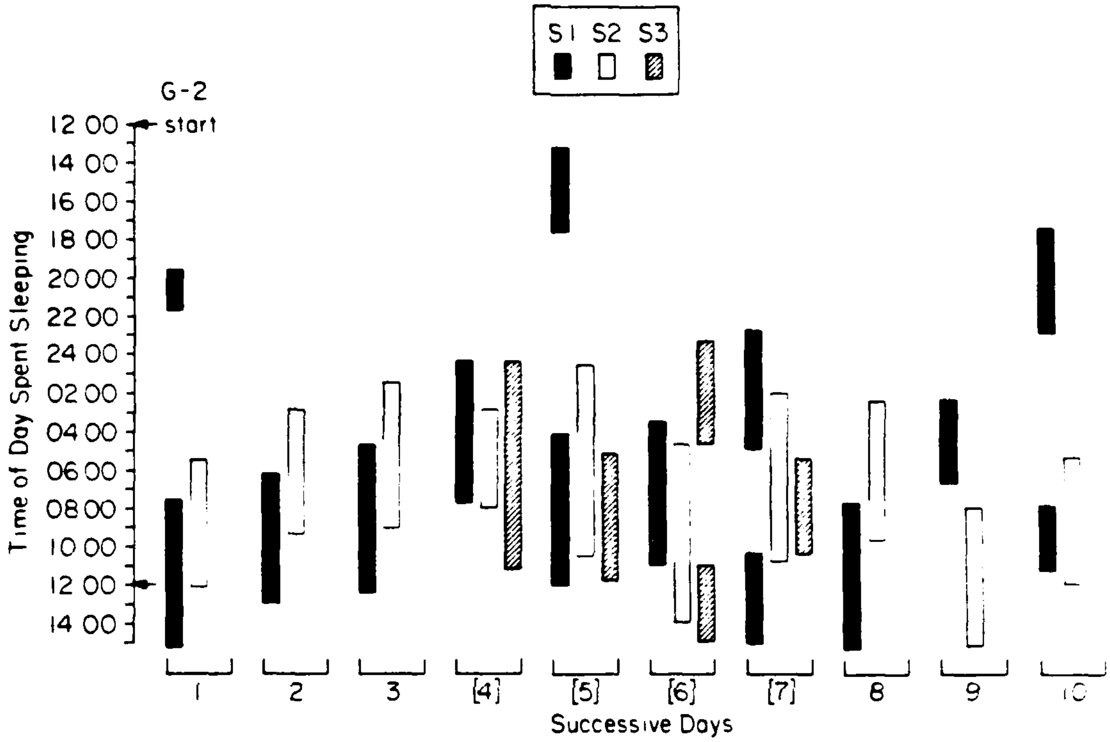


Figure 10. Time of day spent sleeping for all subjects in G2 across successive days of the experiment. A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show sleep periods that persisted across the boundary between successive days. Bracketed Days 4-7 were 3-person days.

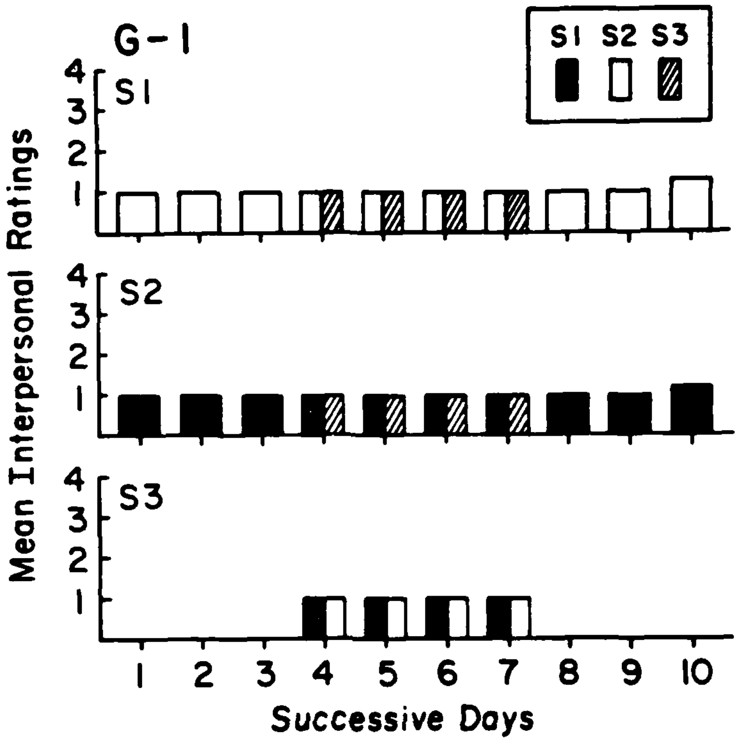


Figure 11. Mean interpersonal ratings for all subject pairs in G1 across successive days of the experiment. 1 = not bothered by a subject, and 4 = extremely bothered.

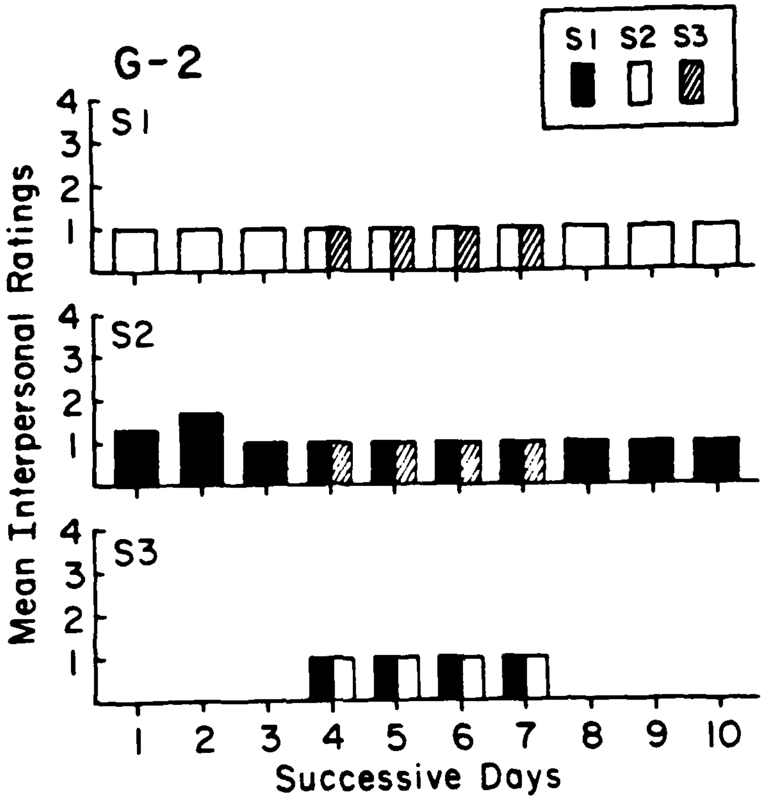


Figure 12. Mean interpersonal ratings for all subject pairs in G2 across successive days of the experiment. 1 = not bothered by a subject, and 4 = extremely bothered.

interpersonal effects in relationship to the introduction and withdrawal of the novitiate. In both groups, the only departures from a "1" rating occurred during the dyadic condition (e.g., G1, S2, Day 10; G2, S2, Day 2).

Members within both groups selected social activities on almost all days of the experiments. These data are shown in Figures 13 and 14 that present social activity durations for G1 and G2, respectively, across successive days of the experiments. In G1, a dyadic social activity was not selected on Day 2. On remaining days, dyadic episodes ranged in duration from 120 min to 195 min, and triadic episodes ranged in duration from 160 to 210 min. In G2, a social activity was selected on each day of the experiment. Dyadic episodes ranged in duration from 90 min to 240 min, and triadic episodes ranged in duration from 120 min to 160 min. No group member in G2 ever refused to participate in a social episode that was required each day for remuneration to accrue to all subjects.

An analysis of testosterone levels obtained from 24-hour total urine volumes collected during both experiments showed changes in relationship to changing the size and composition of a group. These data are shown in Figures 15 and 16 that present total urinary testosterone for all subjects within G1 and G2, respectively, across successive days of the experiments. As indicated by the asterisks, sampling error precluded hormonal data for S2 in G1 on Days 1 and 2. As shown in Figure 15, in G1 the testosterone levels of the established 2-person group members dropped when the novitiate member was introduced, and they recovered to initial levels over successive days. Significantly, the novitiate member's testosterone levels were consistently high in comparison to his teammates. As shown in Figure 16,

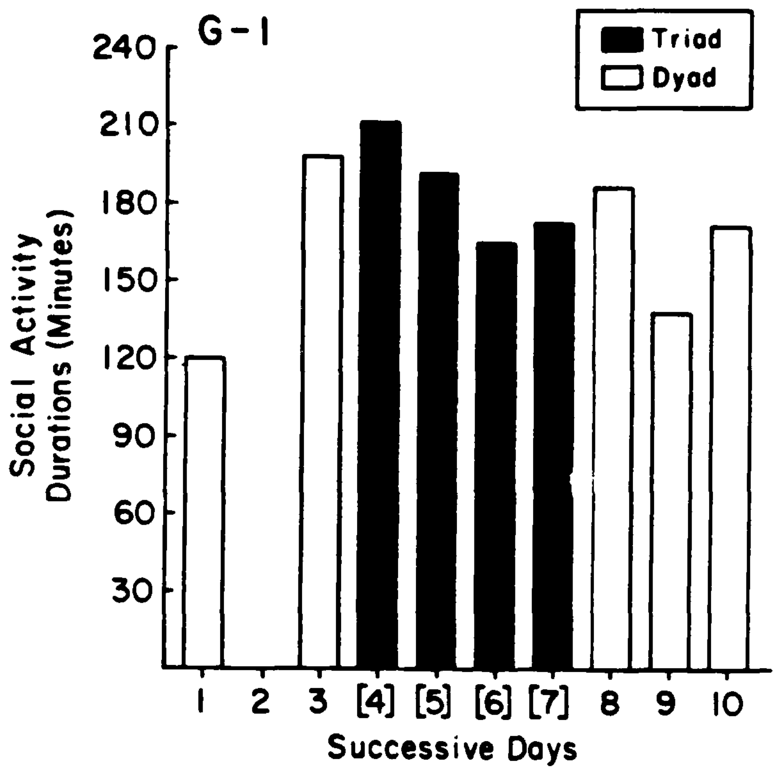


Figure 13. Social activity durations for subjects in G1 across successive days of the experiment. Bracketed Days 4-7 were 3-person days.

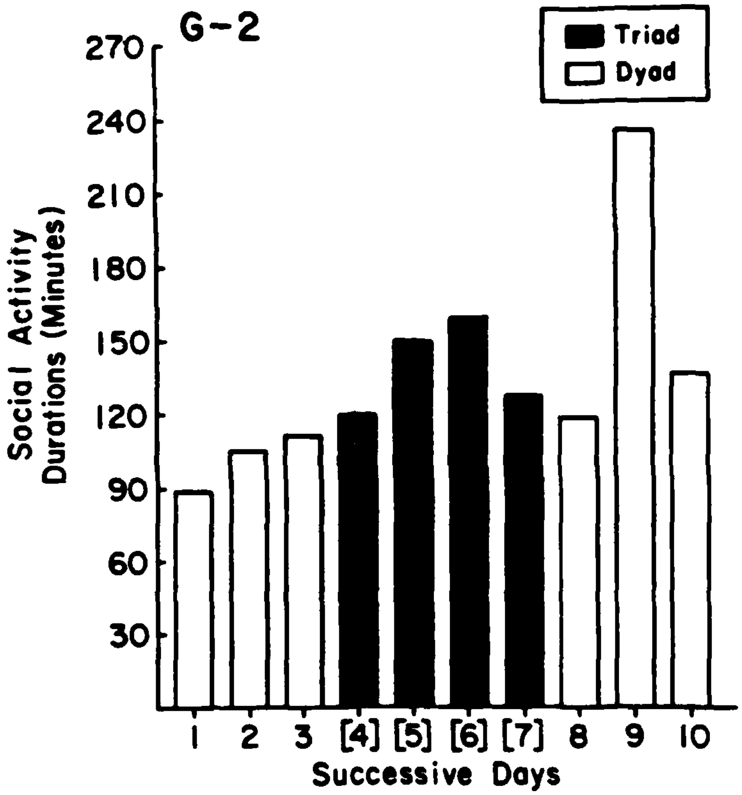


Figure 14. Social activity durations for subjects in G2 across successive days of the experiment. Bracketed Days 4-7 were 3-person days.

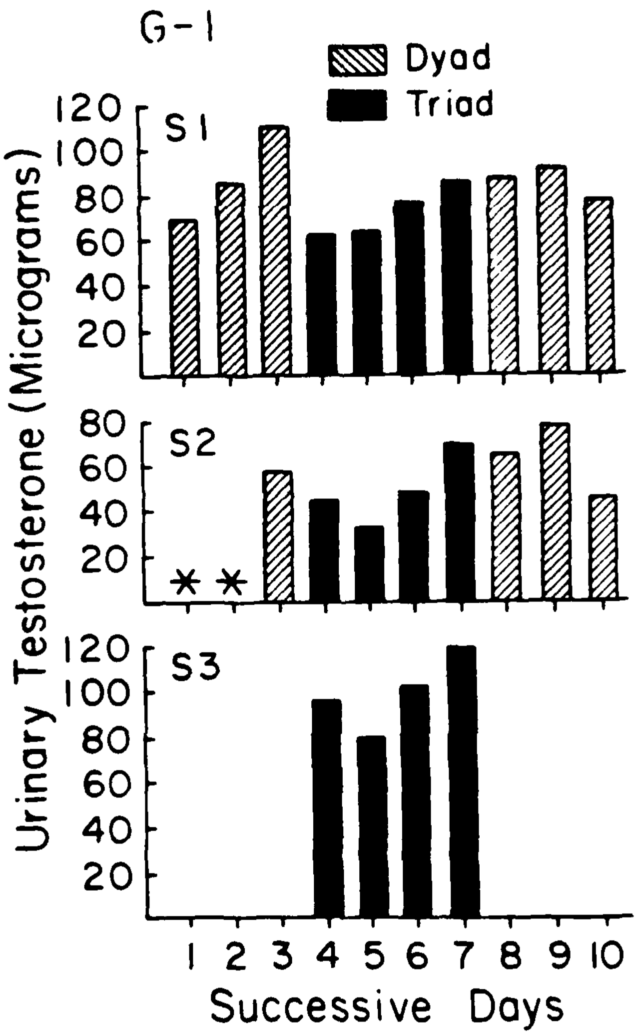


Figure 15. Total urinary testosterone for all subjects in G1 across successive days of the experiment.

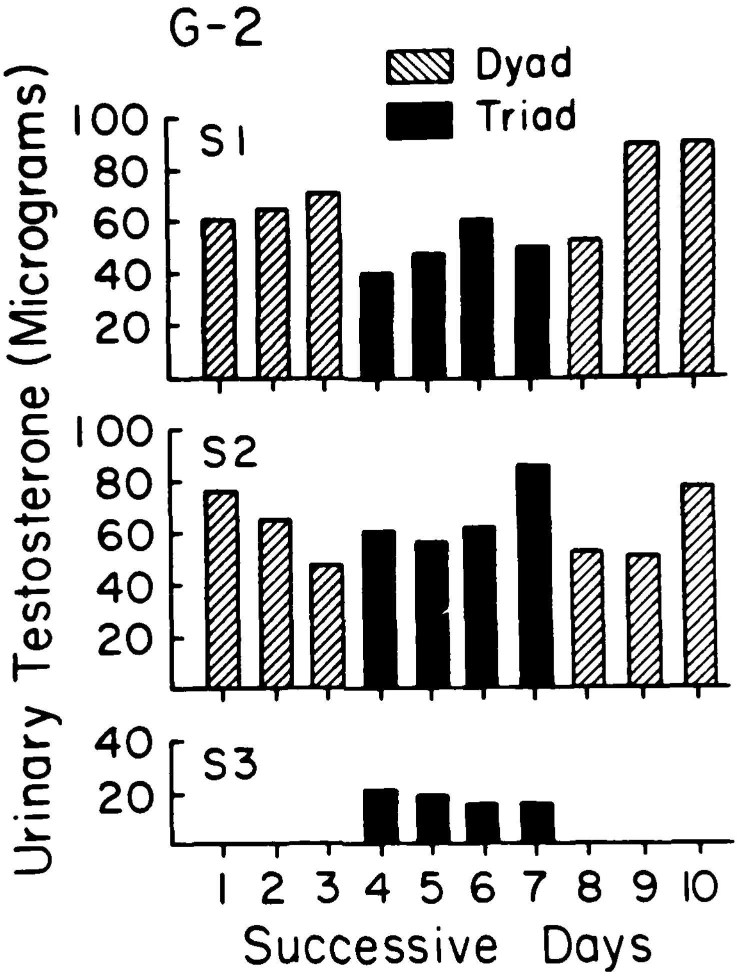


Figure 16. Total urinary testosterone for all subjects in G2 across successive days of the experiment.

in G2 only S1 showed a drop in testosterone levels when the novitiate was introduced. In G2 the novitiate member showed clinically low testosterone levels. Most notably, perhaps, the high testosterone levels observed in the novitiate in G1 and the low testosterone levels observed in the novitiate in G2 may have reflected active processes associated with joining the respective established groups, but the absence of baseline levels precludes such an interpretation.

Group 3: Novitiate Baseline Control Levels

The third 10-day experiment assessed further the effects on individual and social behavior of a novitiate participant's introduction into and withdrawal from a previously established 2-person social system. This systematic replication of the 2 previous studies focused upon participants' testosterone levels in relationship to the changes in group size and composition. The replication involved procedural innovations intended (1) to potentiate the outgroup status of the third participant who joined the ongoing 2-person group, and (2) to provide baseline hormonal levels for the novitiate before and after his participation as a group member.

The 2-person group resided for 10 succesive days within the continuously programmed environment. Participants followed a behavioral program of contingently scheduled activities that determined individual and social behavior. Separate from the behavioral program was access to the work station containing the MTPB and a Serial Learning (SL) task. The SL task was available only in G3 and it involved learning sequences of 10 randomly mixed characters. Accurate operation of the MTPB and SL tasks

produced "accuracy points" that were deposited in a joint account to be divided evenly between the two 10-day participants at the conclusion of the experiment and that determined remuneration for participation. Finally, simultaneous access to the social areas was not required: participants were permitted access to those areas alone, in pairs, or as a triad.

After 4 successive days (Days 1-4) under dyadic conditions, the third participant was introduced as a member of the group on Day 5. For 3 preceding days (Days 2-4), this third participant resided in a private chamber, but his behavioral program lacked communication, social, and work opportunities. This 3-day period provided a hormonal baseline against which to evaluate the effects of joining the group. During those baseline "alone" days, the novitiate received a fixed per diem payment. During the next four 3-person group days (Days 5-8), the novitiate participant was required to operate the MTPB and SL tasks for his <u>individual</u> remuneration. At the conclusion of this 4-day period, the third participant left the group for a final 2-day baseline period (Days 9-10) within his private chamber while the established group returned to its status as a 2-person team.

<u>Figure 17</u> presents total performance points (MTPB plus SL) for all subjects in G3 across successive days of the experiment. This figure shows that performance productivity by the two 10-day participants was not demonstrably affected during Days 5-8 when the novitiate was also a group member. Subject 3, the novitiate participant, showed the highest total points on Days 7 and 8 in comparison to remaining group members. This effect was attributable, at least in part, to his skill at solving the

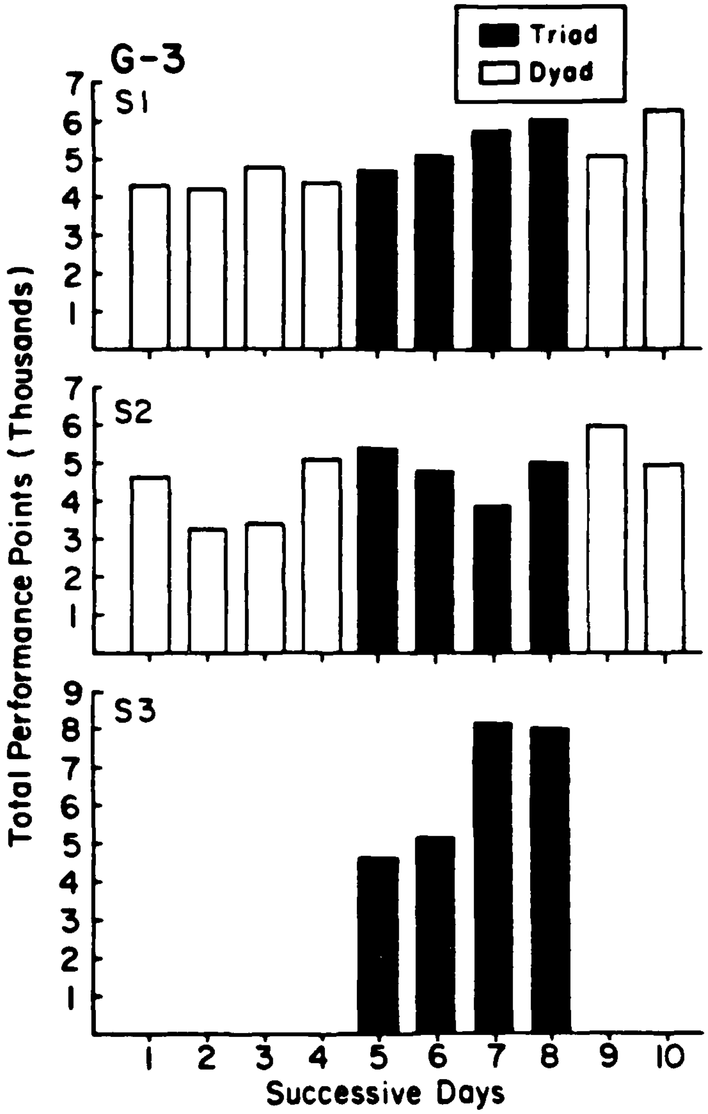


Figure 17. Total performance points for all subjects in G3 across successive days of the experiment.

Serial Learning task, and he selected that task more often than he selected the MTPB. Significantly, these data indicate the ability of the 2-person group to maintain established productivity when the novitiate was accomodated into the work schedule.

Figure 18 presents time of day spent working for all subjects within G3 across successive days of the experiment. A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show work periods that persisted across the boundary between successive days. Bracketed Days 5-8 were 3-person days. During Days 1-3, two-person group members alternated occupancy of the work station, with several work periods occurring each Day. Work periods ranged in duration from less than 1 hour (S1, Day 2) to almost 5 hours (S1, Day 3). The novitiate commenced working at 1200 hours on Day 5, which marked the change of day, without communicating his intentions to other group participants. Subsequently on the same day, he initiated 2 additional work periods. As a result of reactions of the two 10-day participants to this intrusion into the established work schedule, as evidenced by intercom conversations, the novitiate participant shifted his work episodes to later periods of the day across Days 5-8. The accommodation of the novitiate into the work schedule by the two 10-day participants is indicated by the more frequent sustained work periods exhibited by participants while the novitiate was a member of the group. The pattern of work on Day 7 is almost identical to that on Day 8. When the novitiate left the group for Days 9 and 10, 2-person group members resumed the pattern of work that was observed during Days 1-4.

A more striking effect of the impact of the novitiate on the status of

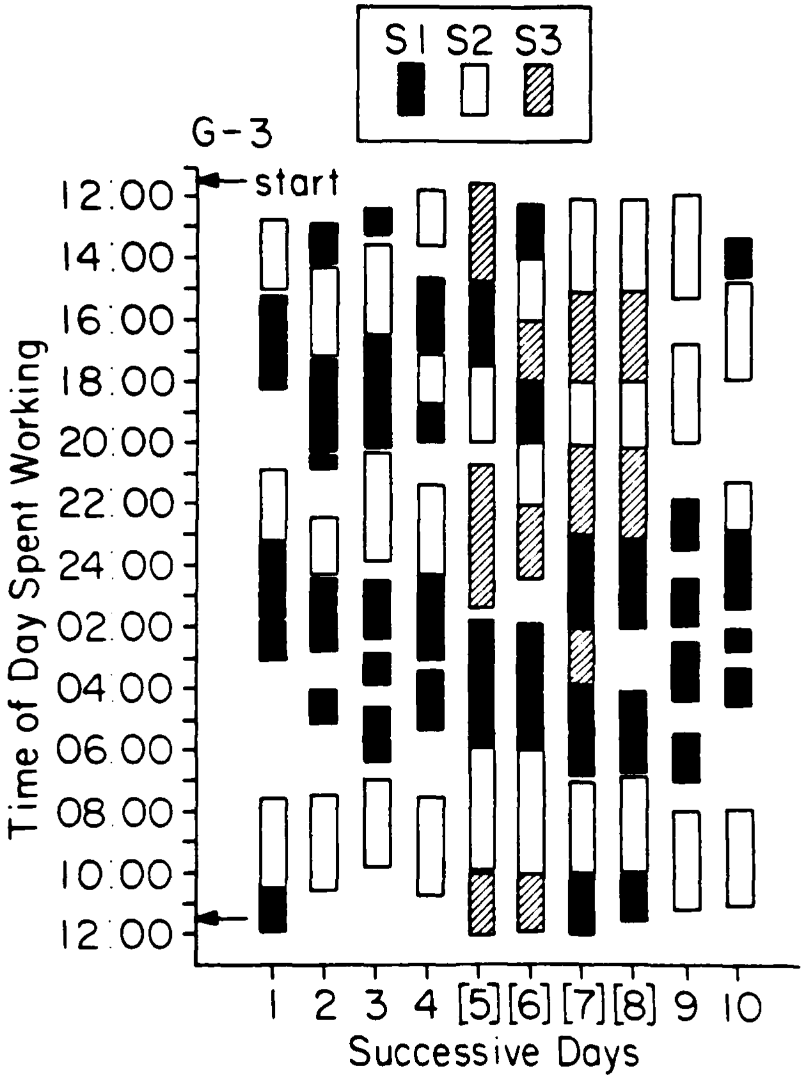


Figure 18. Time of day spent working for all subjects in G3 across successive days of the experiment. A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show work periods that persisted across the boundary between successive days. Bracketed Days 5-8 were 3-person days.

the social system was revealed by the changes in wake-sleep cycles that occurred when the novitiate joined the group. Figure 19 presents time of day spent sleeping for all subjects within G3 across successive days of the experiment. A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show sleep periods that persisted across the boundary between successive days. Bracketed Days 5-8 were 3-person days. Time of day spent sleeping during triadic Days 5-8 changed most for S1, less for S3, and was comparatively undisturbed for S2. These effects are attributable to the restriction that only 1 subject at a time could use the work station.

Figure 20 presents mean interpersonal ratings for all subject pairs within G3 across successive days of the experiment. The data are notable for the absence of changes in relationship to the introduction of the novitiate. The only increase over a "1" rating was observed on Day 6 by S1 who assigned a negative rating to the novitiate.

Figure 21 presents social activity durations for all subjects within G3 across successive days of the experiment. Bracketed Days 5-8 were 3-person days. The order of the social episode within a day is indicated by successive ordinal positions above the abscissa. Numbers within open bars denote pair members composing a dyadic episode. This figure shows that the two 10-day participants engaged in dyadic episodes on 4 of the 6 dyadic days and on 2 of the 4 triadic days. Dyadic episodes by the 10-day participants ranged in duration from 40 min (Day 5) to 100 min (Day 9). Only 1 triadic social episode was observed (Day 5), and the novitiate engaged in only one dyadic episode (Day 5). Thus, although the novitiate

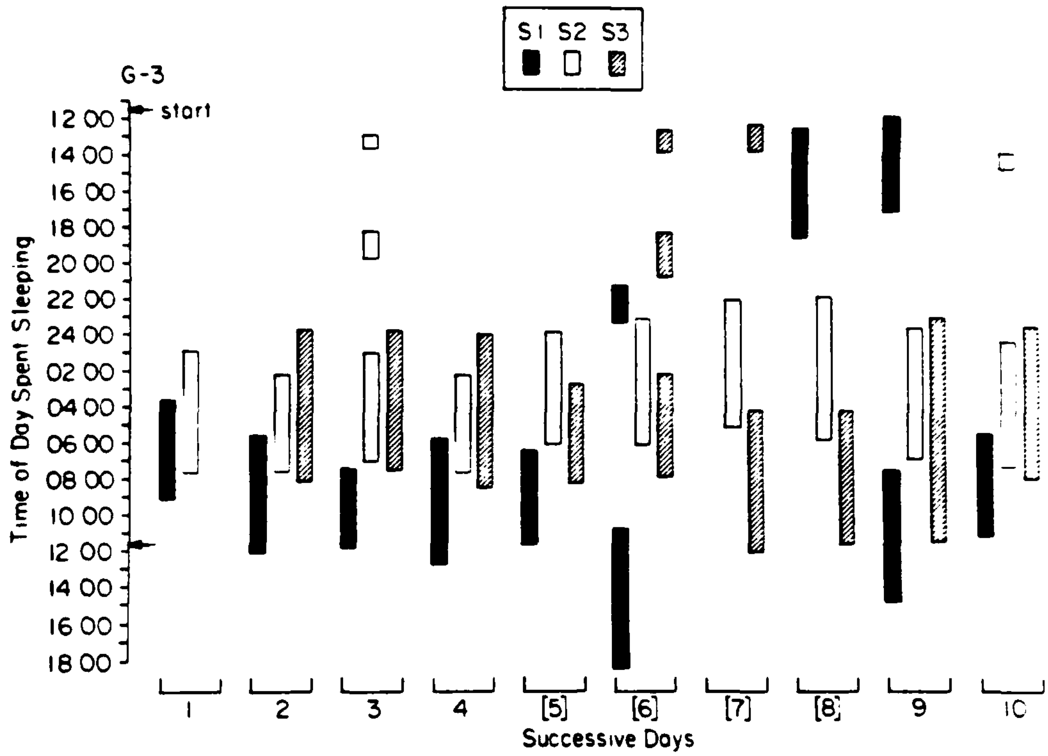


Figure 19. Time of day spent sleeping for all subjects in G3 across successive days of the experiment. A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show sleep periods that persisted across the boundary between successive days. Bracketed Days 5-8 were 3-person days.

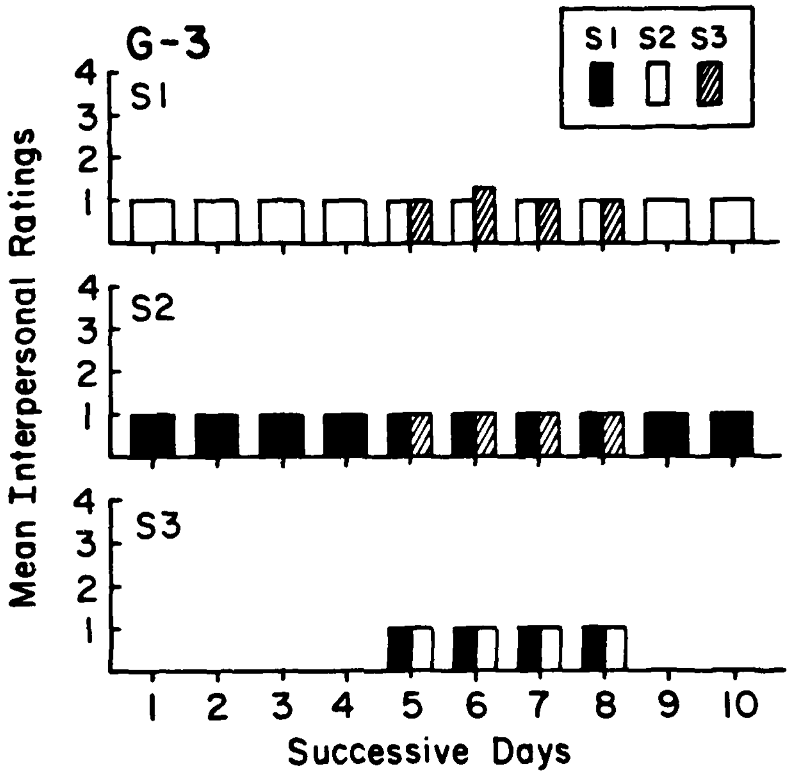


Figure 20. Mean interpersonal ratings for all subject pairs in G3 across successive days of the experiment. 1 = not bothered by a subject, and 4 = extremely bothered.

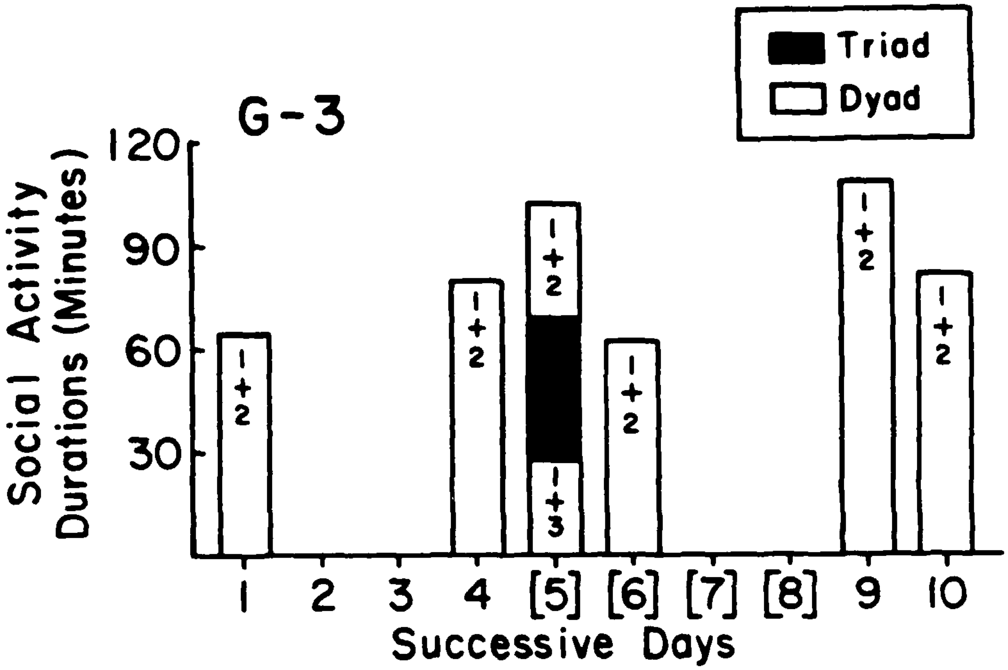


Figure 21. Social activity durations for all subjects in G3 across successive days of the experiment. The order of a social episode within a day is indicated by successive ordinal positions above the abscissa. Numbers within open bars denote pair members composing a dyadic episode. Bracketed Days 5-8 were 3-person days.

was accomodated into the work schedule, he did not occasion the degree of social interaction that was observed in G1 and G2, although the contingencies for social behavior differed between G2 and G3.

An analysis of testosterone levels obtained from 24-hour total urine volumes collected during the experiment showed changes by 2 of the group participants as a function of the 2-person and 3-person conditions. As shown in Figure 22, S1, a 10-day group participant whose basal testosterone levels were low in comparison to reported normal male levels, showed increases in testosterone when the novitiate was introduced into the group, and his levels declined during the final two 2-person days of the study. Significantly, this participant was the only group member expressing irritation with the novitiate member as determined from interpersonal ratings obtained during the Health Assessment activity. The novitiate participant showed a marked decline in testosterone levels across the four 3-person days, with a recovery to baseline levels during his last 2 solitary days of the experiment. Testosterone produced by S2 was stable after a decline across the first 2 days of the study. Significantly, S2 showed the least change in his established wake-sleep patterns whereas S1 and S3 showed pronounced changes. These data suggest that the organization of a social system and its subsequent reorganization under the specified rule conditions impacted upon endocrine system activity as revealed by corresponding changes in testosterone levels among mission participants.

In G3, the magnitude of the drop in testosterone exhibited by the novitiate in comparison to levels observed during baseline days suggested an active process associated with the joining of the grou; and it

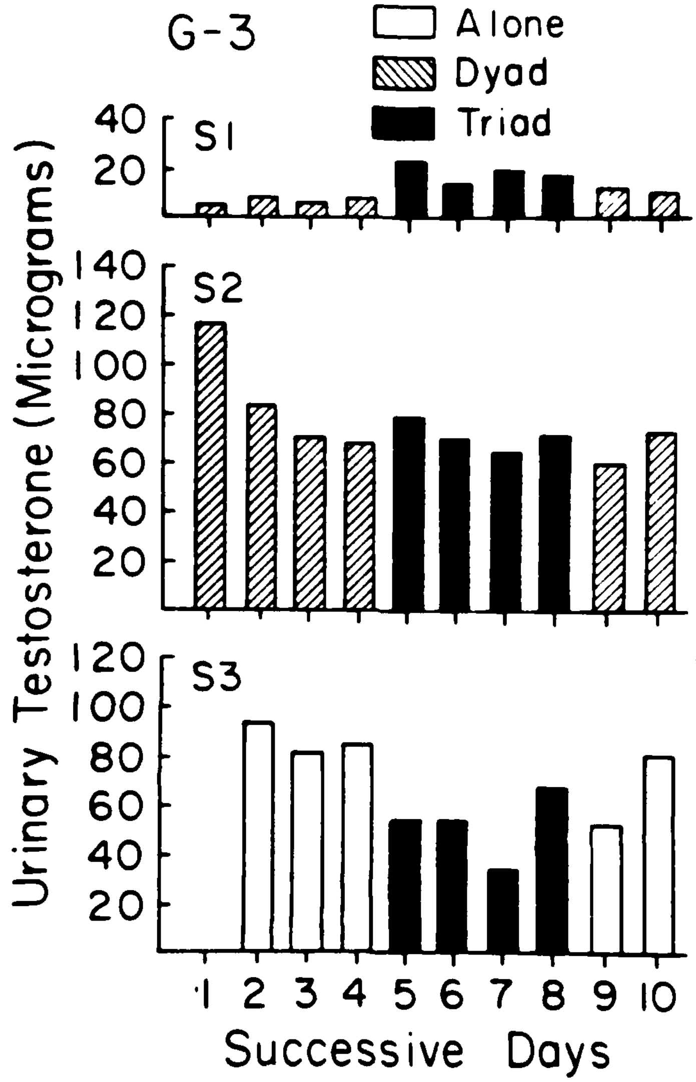


Figure 22. Total urinary testosterone for all subjects in G3 across successive days of the experiment.

emphasized the importance of baseline observations on all 3 group participants. Accordingly, a fourth experiment was conducted to incorporate procedural changes intended to provide baseline hormonal levels prior to both dyadic and triadic group formation.

G4: Group Baseline Control Levels

In addition to dyadic and triadic social conditions to be described, the fourth 10-day experiment was composed of baseline and work days. On baseline "alone" days, participants followed a behavioral program in their individual rooms, but without having access to work, intercom communications, or social activities. During baseline days, subjects received a per diem allowance. On work days, participants also followed a behavioral program that included social activities and intercom communications, and they were required to operate the MTPB for their earnings.

The 2-person group participants resided for 10 successive days within the continuously programmed environment. Days 1-3 were solitary baseline days with no work opportunities, and on Day 4, participants formed a 2-person team with competitive work opportunities. That is, a participant's MTPB accuracy-point earnings were deposited within his individual account that was awarded to him at the conclusion of the experiment. This 2-person work condition was in effect from Days 4-6. Also on Day 4, the novitiate participant began his baseline days within his private quarters, remaining under such conditions from Days 4-6. On Day 7, the novitiate participant joined the previously established 2-person group.

Days 7-10, then, were triadic days with all 3 participants operating the performance battery on a competitive basis. In summary, the design of this experiment allowed assessment of hormonal and behavioral factors under baseline conditions that preceded dyadic team formation and triadic group reorganization.

Figure 23 presents total performance points for all subjects within G4 across successive days of the experiment. Bracketed Days 1-3 were baseline "alone" days for members of the 2-person group. During dyadic Days 4-6, substantial productivity was observed by both members of the 2-person group. When the novitiate joined the group on Days 7-10, daily productivity by the 2-person group declined in relationship to accomodating the third person's access to the work station. During Days 7-10, daily performance productivity was roughly equivalent among the 3 group members.

Figure 24 presents time of day spent working for all subjects within G4 across successive work days of the experiment. Days 1-3 were baseline "alone" days, and bracketed Days 7-10 were 3-person days. A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show work periods that persisted across the boundary between successive days. The 2-person group developed an orderly and alternating sequencing of work intervals throughout dyadic Days 4-6. When the novitiate joined the group on Day 7, this sequencing persisted, but importantly, the novitiate participant assumed the most "preferred" work interval (i.e., 1200-2000 hours). In contrast, S1 worked from 2000 to 0400 hours, and S2 worked during the least preferred time of day (i.e., 0400-1200 hours). When the novitiate was a group member during Days 7-10, the work intervals of the

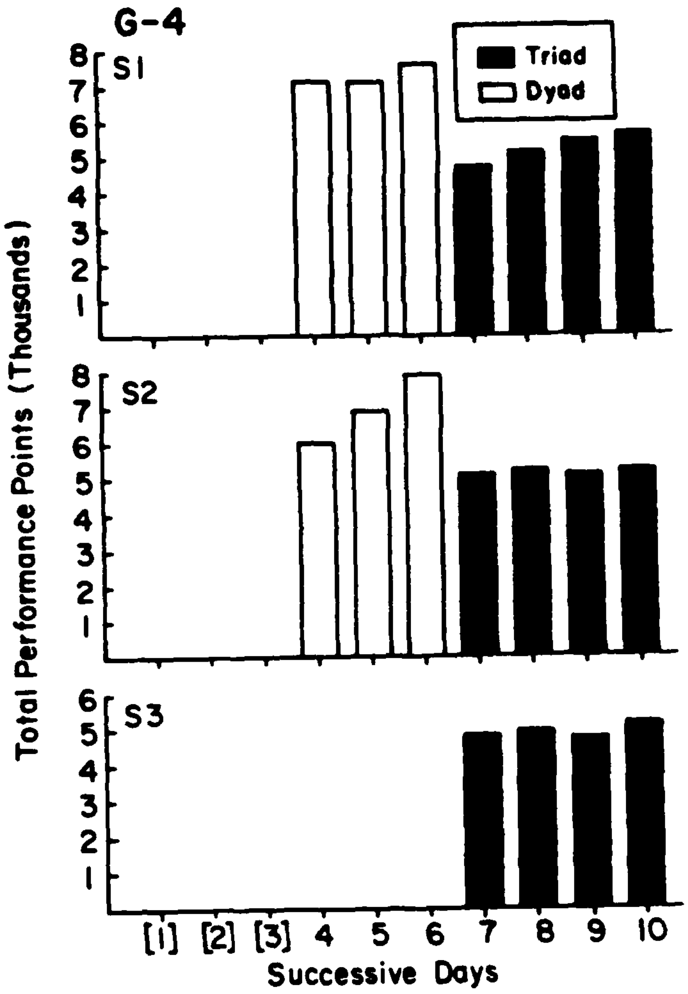


Figure 23. Total performance points for all subjects in G4 across successive days of the experiment. Bracketed Days 1-3 were baseline "alone" days.

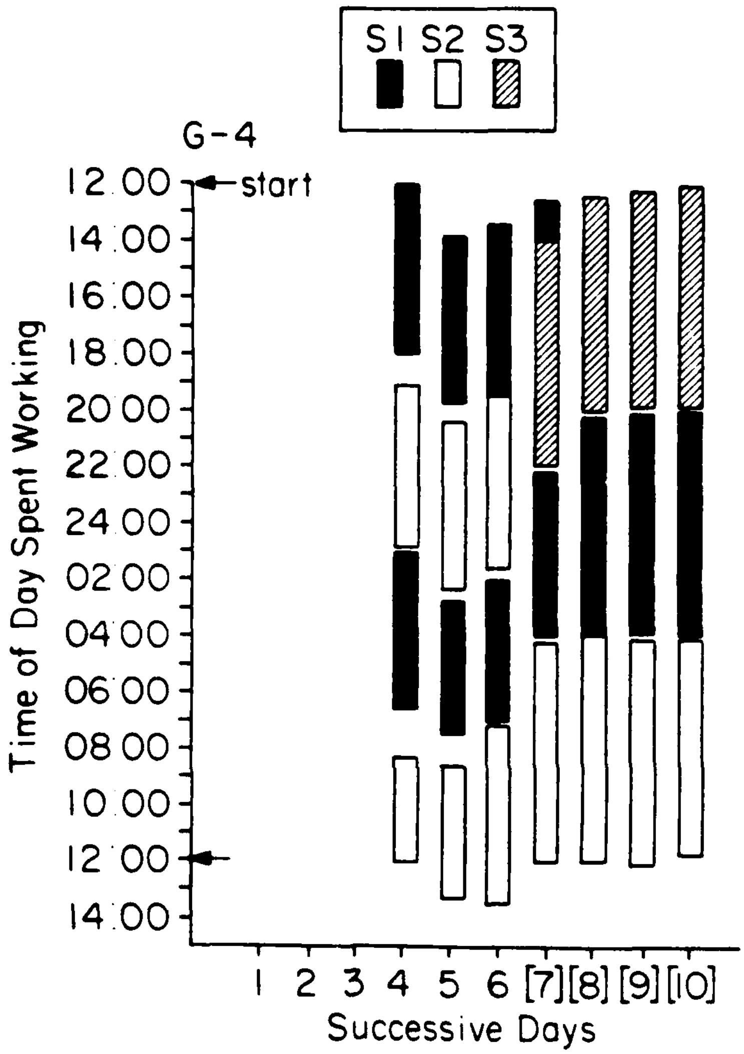


Figure 24. Time of day spent working for all subjects in G4 across successive days of the experiment. Days 1-3 were baseline "alone" days, and bracketed Days 7-10 were 3-person days. A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show work periods that persisted across the boundary between successive days.

two 10-day participants were longer and uninterrupted in contrast to comparatively briefer and more frequent intervals observed throughout Days 4-6. Thus, the novitiate participant exerted a pronounced effect on the routine previously established by the 2-person group, although the change was orderly.

Figure 25 presents time of day spent sleeping for all subjects within G4 across successive days of the experiment. Bracketed Days 7-10 were 3-person days. A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show sleep periods that persisted across the boundary between successive days. Wake-sleep cycles were altered among baseline, dyadic, and triadic days. Sleep periods for the two 10-day participants during Days 1-3 were synchronous with a typical day-night orientation, uninterrupted, and at least 8 hours in duration. During dyadic Days 4-6, however, some disruption in sleep patterns by the dyadic group is evident in response to those members' adaptation to the performance tasks. In this regard, during Days 4-6, S1 and S2 occupied the work station for almost 24 hours each day. The most striking change occurred, however, when the novitiate joined the group on Day 7. Throughout Days 7-10, S2 showed a pronounced and consistent shift in his sleep period, S1 showed a moderate adjustment that extended into the early hours of an experimental day (that commenced at 1200 hours), and most importantly, S3 showed no notable change in sleep patterns in comparison to his baseline wake-sleep cycles established during Days 4-6.

Figure 26 presents mean interpersonal ratings for all subject pairs within G4 across successive "work" days of the experiment. These data are

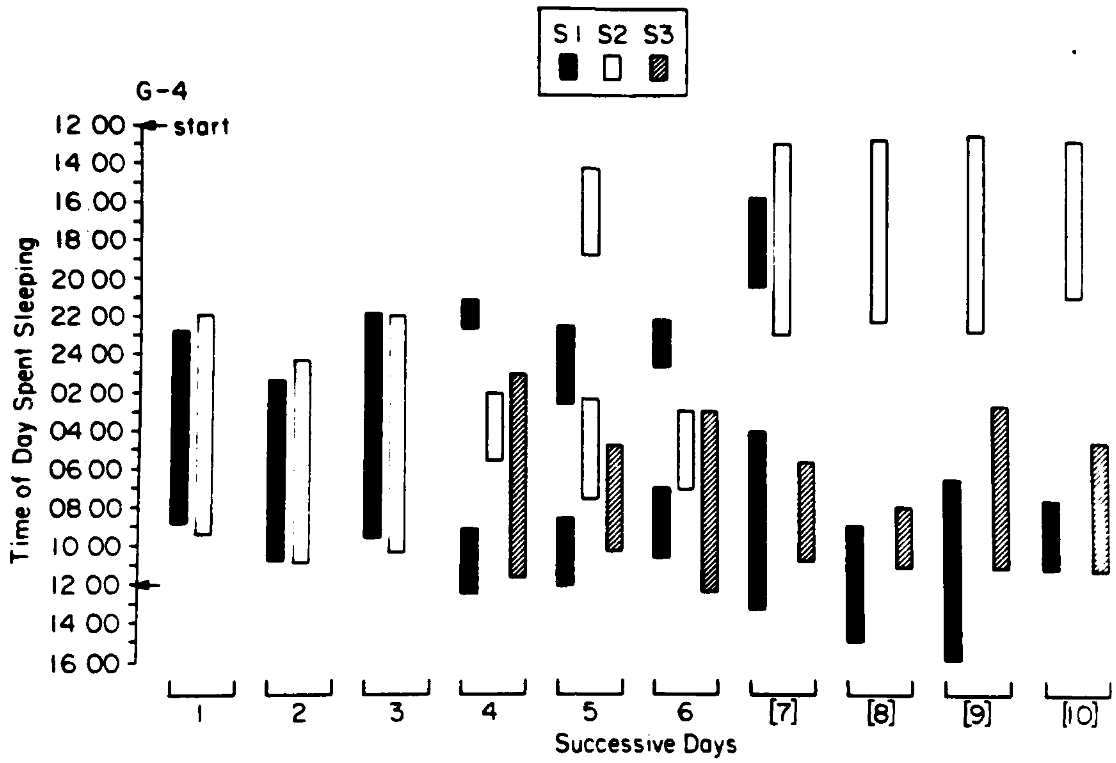


Figure 25. Time of day spent sleeping for all subjects in G4 across successive days of the experiment. Days 1-3 were baseline "alone" days, and Days 7-10 were 3-person days. A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show sleep periods that persisted across the boundary between successive days.

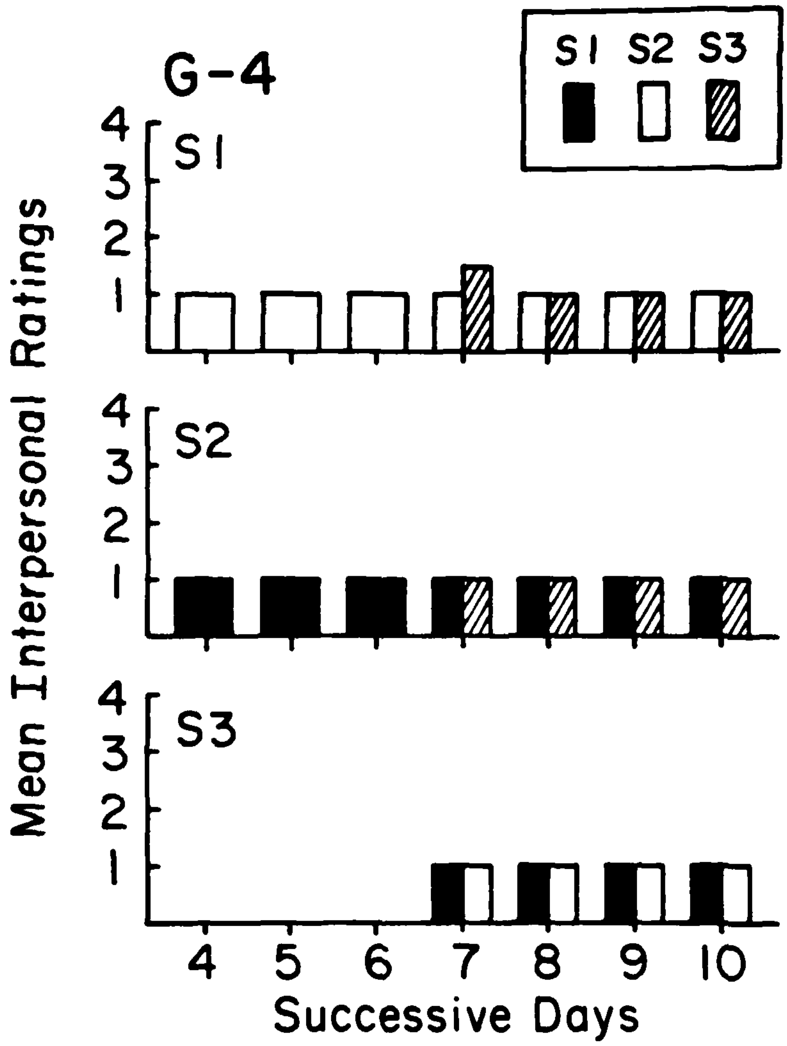


Figure 26. Mean interpersonal ratings for all subject pairs in G4 across successive days of the experiment. 1 = not bothered by a subject, and 4 = extremely bothered.

notable for the absence of persistent negative interpersonal effects in relationship to the introduction of the novitiate. The only departure from a "1" rating was directed toward the novitiate by S1 on Day 7.

Figure 27 presents social activity durations for all subjects within G4 across successive "work" days of the experiment. Days 1-3 were baseline "alone" days, Days 4-6 were 2-person days, and bracketed Days 7-10 were 3-person days. The order of a social episode within a day is indicated by successive ordinal positions above the abscissa. Numbers within open bars denote pair members composing a dyadic episode. During dyadic Days 4-6, the 2-person group selected two 1-hour social episodes on Day 4. During triadic Days 7-10, a triadic episode never occurred. A dyadic episode occurred on Days 7 and 8, and each episode involved the novitiate and S2 and the novitiate and S1, respectively. These latter dyadic episodes were over twice the duration of the 2 dyadic episodes involving the original dyadic group members. These effects suggest that the reinforcing strength of a triadic social opportunity was not sufficiently robust to compete with access to the performance station, at least during the 4-day triadic period.

An analysis of testosterone levels obtained from 24-hour total urine volumes collected during the experiment showed orderly relationships to the observed changes in wake-sleep cycles and work time. As shown in Figure 28, S1 and S2, the two 10-day participants, showed intermediate testosterone levels across the baseline and dyadic days of the experiment with some indication of a decline in S2's levels across Days 4-6. These levels are comparable to those exhibited by the novitiate, S3, throughout

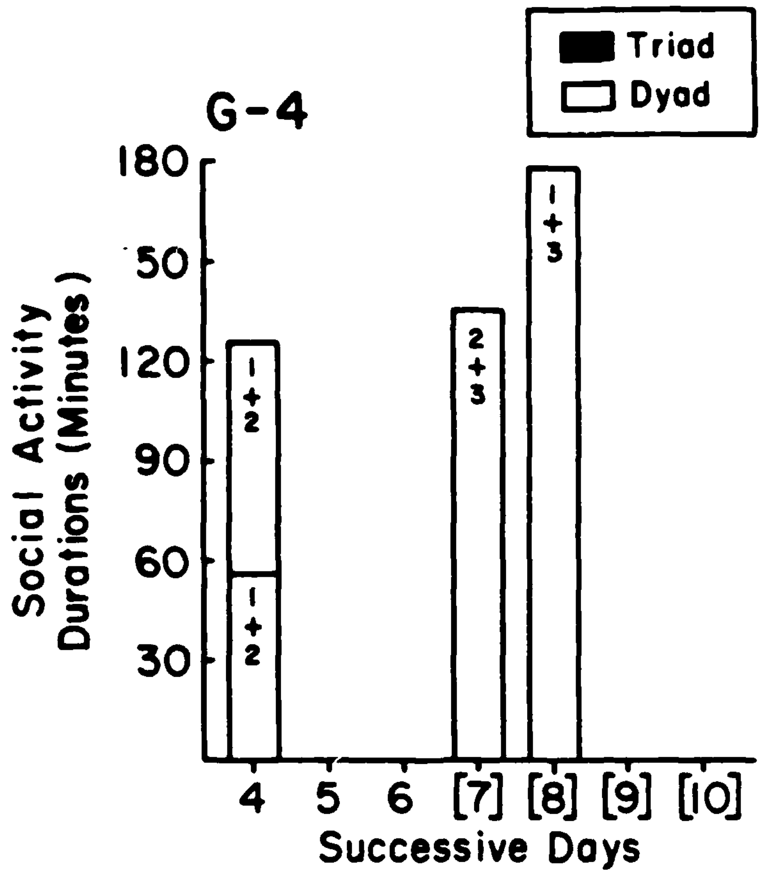


Figure 27. Social activity durations for all subjects in G4 across successive days of the experiment. The order of a social episode within a day is indicated by successive ordinal positions above the abscissa. Numbers within open bars denote pair members composing a dyadic episode. Bracketed Days 7-10 were 3-person days.

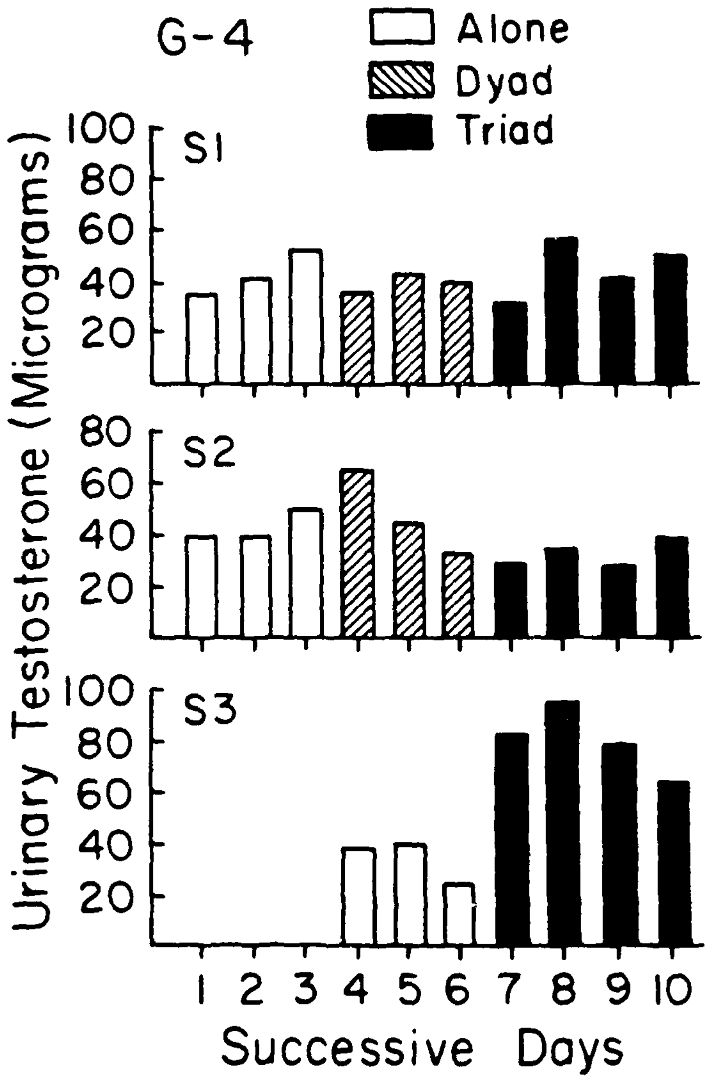


Figure 28. Total urinary testosterone for all subjects in G4 across successive days of the experiment.

his baseline Days 4-6. When the novitiate participant joined the group on Day 7, his testosterone levels at least doubled, and these substantially elevated levels persisted throughout the remaining 4 triadic days of the experiment. In contrast, testosterone levels of the two 10-day participants dropped when the novitiate joined the group, although S2 showed some recovery across Days 7-10 to those levels observed throughout the 6 preceding days.

In summary, then, the participant (S2) who showed the greatest shift in his wake-sleep cycles when the novitiate joined the group also showed a reduction in testosterone throughout the 4 triadic days of the study. Conversely, the novitiate participant (S3), who showed the least such shift, showed consistent elevations in testosterone throughout the 4 triadic days.

Group 5: Sleep Period Control

Because of the relationships sometimes observed between changes in wake-sleep cycles and changes in testosterone when the novitiate entered the group in G3 and G4, a fifth experiment assessed the effects of introducing a novitiate participant into an established group when the program schedule held the sleep period constant for all subjects.

The experimental design plan for G5 was almost identical to that for G4 with no work opportunities on Days 1-3 and with the following constraint in effect throughout dyadic and triadic work days. Throughout those work days, access to the work station, intercom, and social room was prohibited between 2400 and 0800 hours of each day. This restriction was imposed so

that participants would likely orient their sleep time to those particular hours, although they always had the opportunity to engage in the many remaining individual activities within the behavioral program. Finally, in contrast to G4, the novitiate participant entered the environment on Day 3 for 4 solitary baseline days prior to his entrance into the group on Day 7.

Figure 29 presents total performance points earned by all subjects within G5 across successive "work" days of the experiment. Bracketed Days 1-3 were baseline "alone" days for S1 and S2. In comparison to G4, daily productivity levels were low, and this effect is, of course, attributable to the restriction on work between 2400 and 0800 hours. During triadic Days 7-10 when the novitiate joined the group, intersubject and intrasubject variability was greater than that observed during triadic Days 7-10 in G4.

Figure 30 presents time of day spent working for all subjects within G5 across successive "work" days of the experiment. Days 1-3 were baseline "alone" days, Days 4-6 were 2-person days, and bracketed Days 7-10 were 3-person days. When the dyad was formed on Day 4, the 2 participants (i.e., S1 and S2) developed an orderly sequential pattern of work with each alternating work period lasting approximately 2-4 hours. This pattern persisted throughout Days 4-6. When the novitiate entered the group on Day 7, his integration into the group involved his willing adoption of the previously established work pattern. Throughout Days 7-10, the 3 participants alternated access to the work station with each work period lasting approximately 2 hours and changing at about the same time of day throughout triadic work Days 7-10. It was the case, however, that

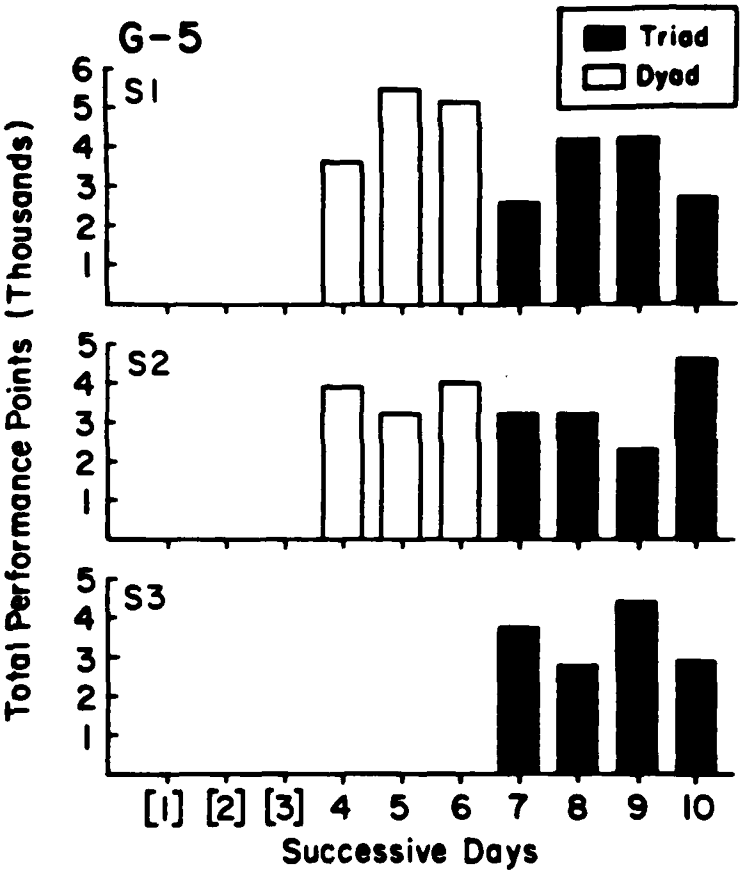


Figure 29. Total performance points by all subjects in G5 across successive days of the experiment. Bracketed Days 1-3 were baseline "alone" days.

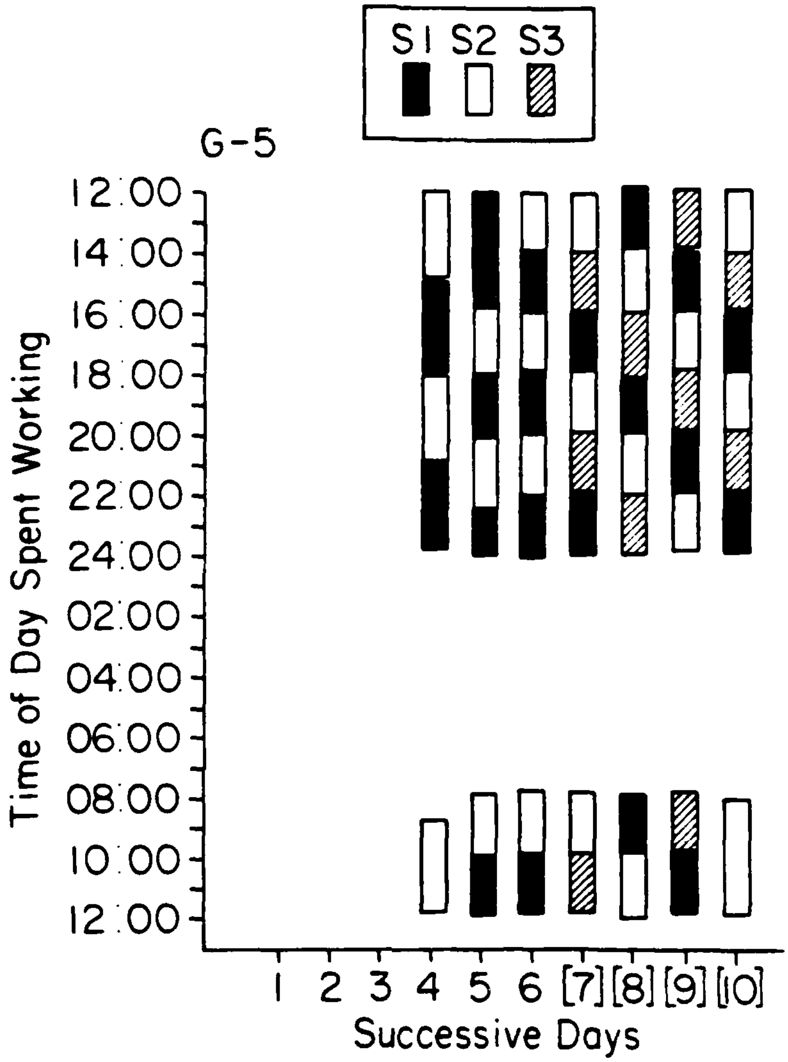


Figure 30. Time of day spent working for all subjects in G5 across successive days of the experiment. Days 1-3 were baseline "alone" days, and Days 7-10 were 3-person days.

participants worked at different times of day across Days 7-10. Thus, this particular novitiate participant was not observed to cause a major disruption in the style of working that developed preceding his entrance into the group, and S1 and S2 did not try to prevent his recurrent access to the work station.

Figure 31 presents time of day spent sleeping for all subjects within G5 across successive days of the experiment. A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show sleep periods that persisted across the boundaries between successive days. Bracketed Days 7-10 were 3-person days. Wake-sleep cycles were stable for all subjects within G5 across successive days. The time of day spent sleeping roughly corresponded to the interval when the activity restrictions were in effect. The only exceptions were observed on Days 5 and 6 when S3 was removed from the behavioral program because of a minor stomach upset, but he remained in the programmed environment and napped during the day hours. These data, then, are in striking contrast to the shifts in wake-sleep cycles observed in the previous experiments when the novitiate became a group member.

Figure 32 presents mean interpersonal ratings for all subject pairs in G5 across successive "work" days of the experiment. These data are notable for the absence of reported interpersonal irritation. Only one departure from a "1" rating was observed (Day 7, S3 toward S2).

Figure 33 presents social activity durations for all subjects within G5 across successive "work" days of the experiment. Bracketed Days 7-10

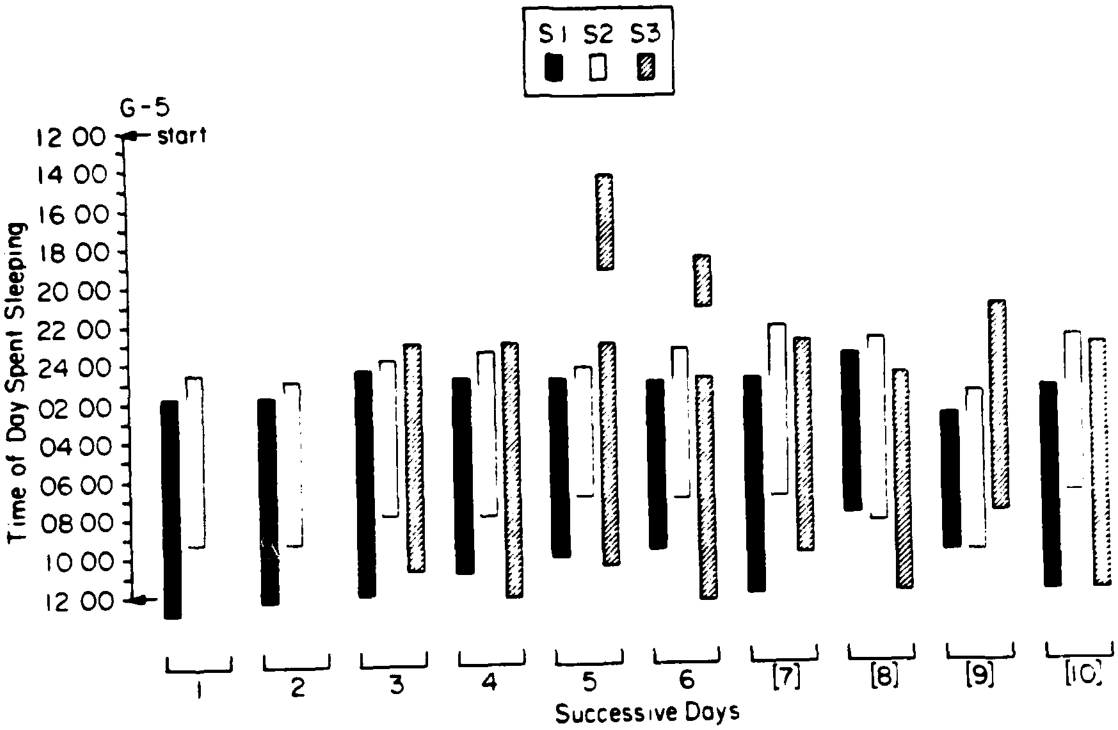


Figure 31. Time of day spent sleeping for all subjects in G5 across successive days of the experiment. Days 1-3 were baseline "alone" days, and Days 7-10 were 3-person days. A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show sleep periods that persisted across the boundary between successive days.

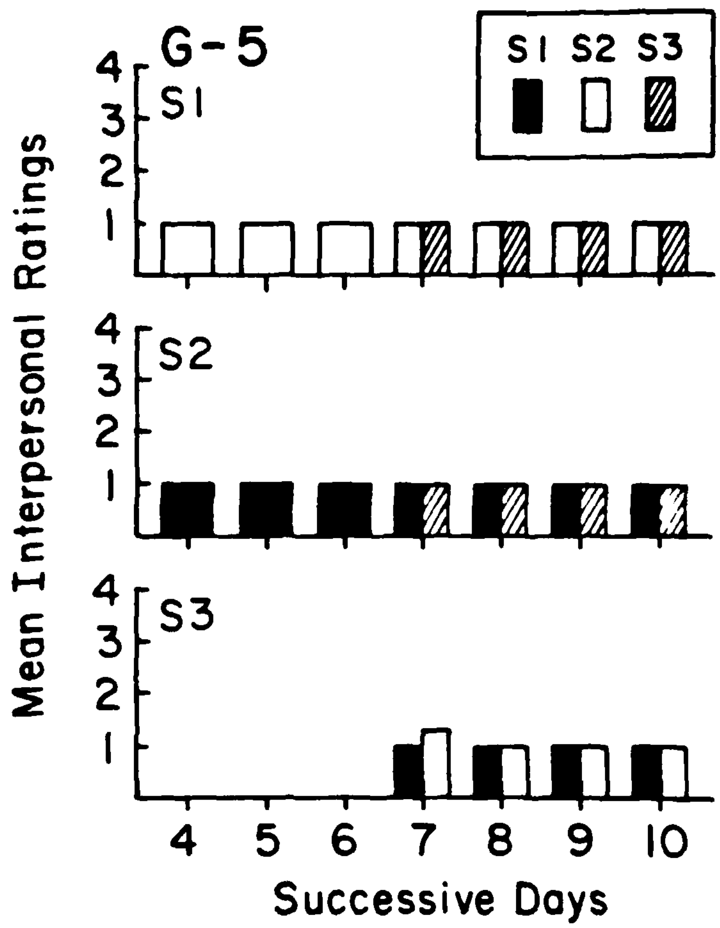


Figure 32. Mean interpersonal ratings for all subject pairs in G5 across successive days of the experiment. Days 1-3 were baseline "alone" days. 1 = not bothered by a subject, and 4 = extremely bothered.

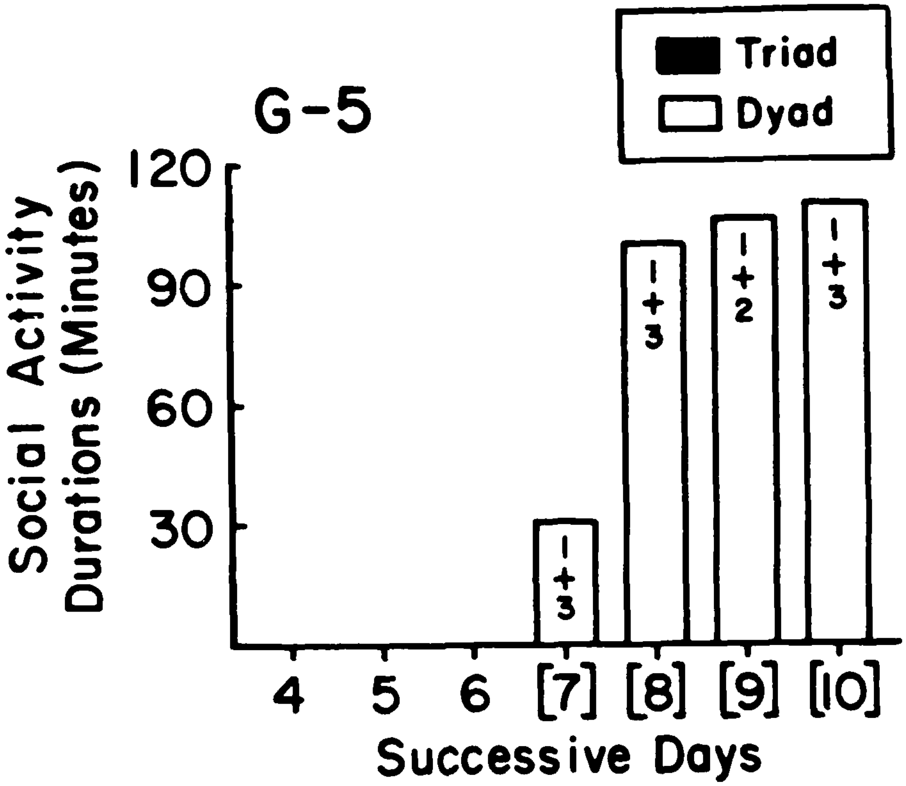


Figure 33. Social activity durations for all subjects in G5 across successive days of the experiment. The order of a social episode within a day is indicated by successive ordinal positions above the abscissa. Numbers within open bars denote pair members composing a dyadic episode. Days 1-3 were baseline "alone" days, and Days 7-10 were 3-person days.

were triadic days. During dyadic Days 4-6, no social episode was observed. In contrast, a dyadic episode occurred on each of Days 7-10, and they ranged in duration between 30 min to over 100 min. All 4 dyadic episodes involved S1, and only 1 dyadic episode involved the original dyad (Day 9). As in G4, no triadic episode was observed.

The uneventful entrance of the novitiate participant and the absence of resistance by the established dyad were paralleled by the lack of notable changes in urinary testosterone across successive experimental days. As shown in Figure 34, no subject showed a consistent and large-magnitude change in testosterone as a function of the dyadic and triadic conditions. (Sampling error prevented Day 10 determinatons.) Subject 1's levels were low to intermediate, S2's levels were intermediate, and S3's levels were high. These data, then, suggest that irrespective of the variance among participants' baseline testosterone levels, the accomodating and cooperative character exhibited by members of this particular group was sufficient to inhibit confrontations that in previous groups were related to behavioral and hormonal readjustments.

Group 6: Mixed Gender Effects

The 5 previous experiments were undertaken with all-male groups because of the importance of eliminating major sources of intersubject variability during the early phase of a research program. With the completion of G5, however, the database appeared sufficiently robust to warrant an extension of the observed behavioral-biological interactions to a situation involving a mixed-gender group. Accordingly, the sixth experiment within this series involved the introduction of a female

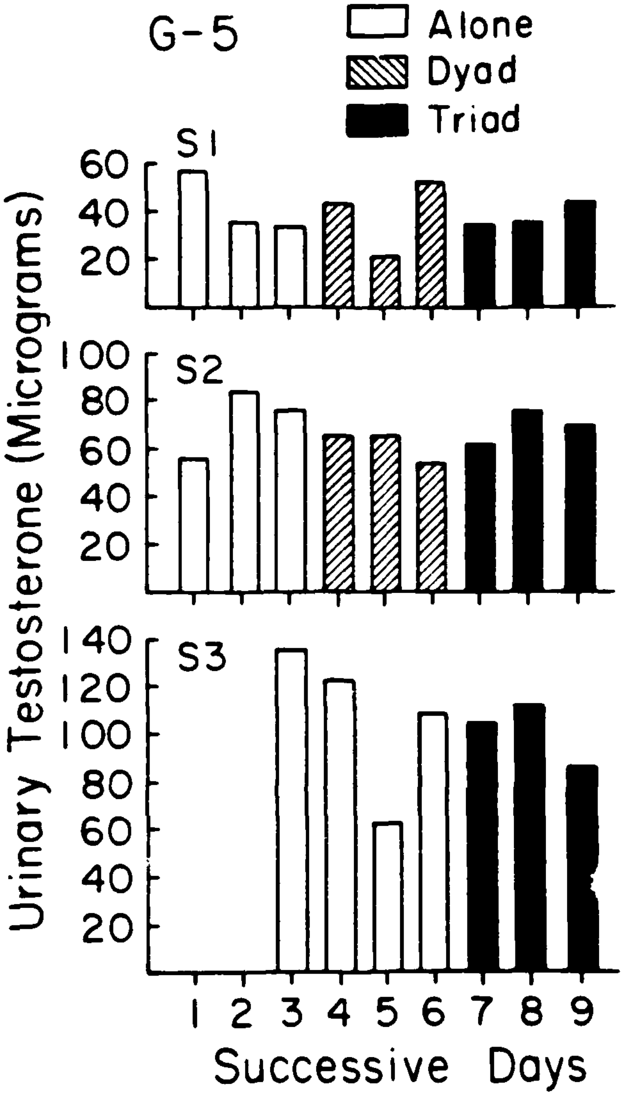


Figure 34. Total urinary testosterone for all subjects in G5 across successive days of the experiment. Sampling error precluded Day 10 determinations.

novitiate participant into an established 2-person male group.

The design plan of this sixth experiment was similar to the one used for G3. The 2-person male group operated the MTPB for 10 successive days, and each participant's accuracy points were deposited within a joint account evenly divided at the conclusion of the experiment. After 4 successive days under dyadic conditions (Days 1-4), the novitiate female participant was introduced as a member of the group. For the 4 preceding days, this participant had resided in her private room under solitary baseline conditions. After 4 successive days under triadic work conditions (Days 5-8), the novitiate was removed from the group for 2 final baseline days (Days 9-10) while the remaining participants again worked as a 2-person group. Unlike all previous experiments, the 2 male participants had previously participated in an earlier study: S1 was a dyadic group member and S2 was the novitiate in G4.

Figure 35 presents total performance points earned by all subjects in G6 across successive days of the experiment. The 3-person condition (Days 5-8) impacted most upon S1 who showed comparatively diminished productivity on Days 5, 6, and 8, and S2 showed somewhat lower productivity across Days 5-8. The novitaite, S3, worked on all 4 triadic days of the experiment.

Figure 36 presents time of day spent working for all subjects in G6 across successive days of the experiment. A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show work periods that persisted across the boundary between successive days. Bracketed Days 5-8 were 3-person days. During Days 1-4, S1 worked during the early hours

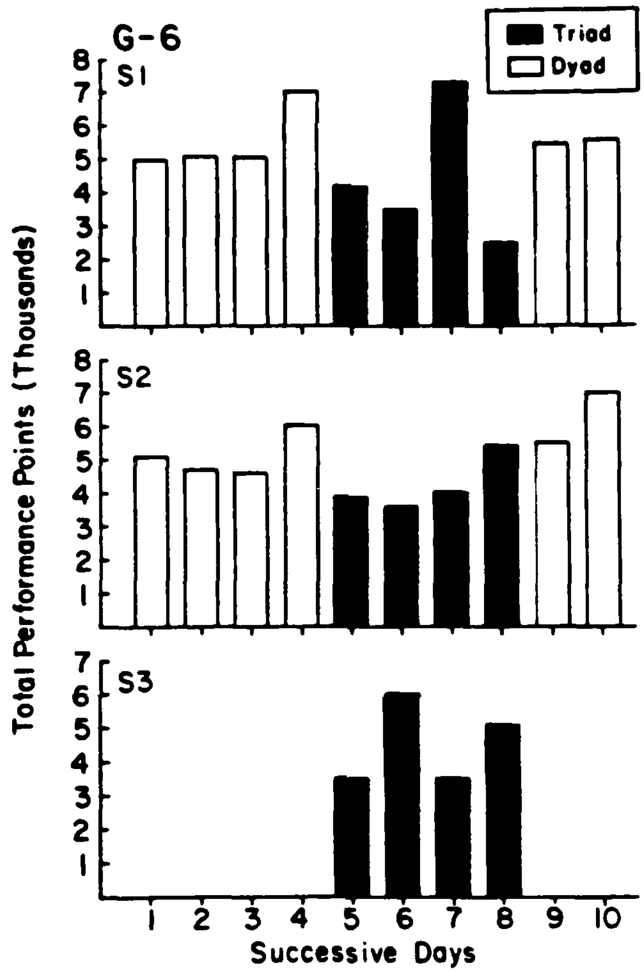


Figure 35. Total performance points for all subjects in G6 across successive days of the experiment.

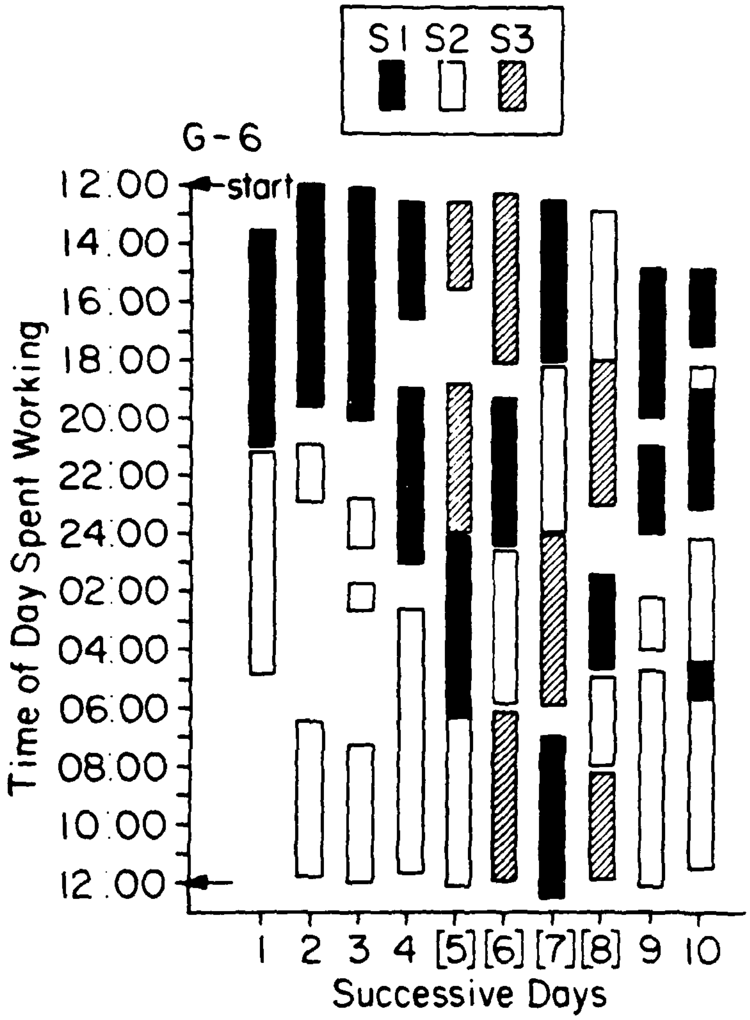


Figure 36. Time of day spent working for all subjects in G6 across successive days of the experiment. Bracketed Days 5-8 were 3-person days. A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show work periods that persisted across the boundary between successive days.

of an experimental day that began at 1200 hours. This is similar to the hours during which he worked in G4 on Days 4-6. Importantly, S2 in the present experiment, who was the novitiate in G4, was not observed to work during the preferred hours as he had in G4 on triadic Days 7-10. On Days 1-4 in G6, the work period alternations were perhaps not so regular as they were on Days 4-6 in G4. When the novitiate participant entered the group on Day 5, she alone worked during the first 12 hours of that day, with S1 and S2 working during subsequent 6-hour intervals, respectively. Thereafter on triadic Days 6-8, subjects alternated access to the work station, but no stable patterns of alternation developed. For all subjects, work periods occurred sporadically throughout the day, rather than being oriented to a specific time of day across successive days of the triadic condition. Finally, when the novitiate left the group at the end of Day 8, the work sequences for S1 and S2 roughly corresponded to those observed during dyadic Days 1-4.

Figure 37 presents time of day spent sleeping for all subjects within G6 across successive days of the experiment. A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show sleep periods that persisted across the boundary between successive days. Bracketed Days 5-8 were 3-person days. No subject maintained consistent wake-sleep cycles across successive days of the experiment. Although cycles were comparatively regular during Days 1-4 when S1 and S2 worked as a dyad and S3 lived alone under baseline, when the novitiate entered the group on Day 5, wake-sleep cycles were thereafter erratic on triadic Days 5-8. When the novitiate left the group at the end of Day 8, wake-sleep cycles did not

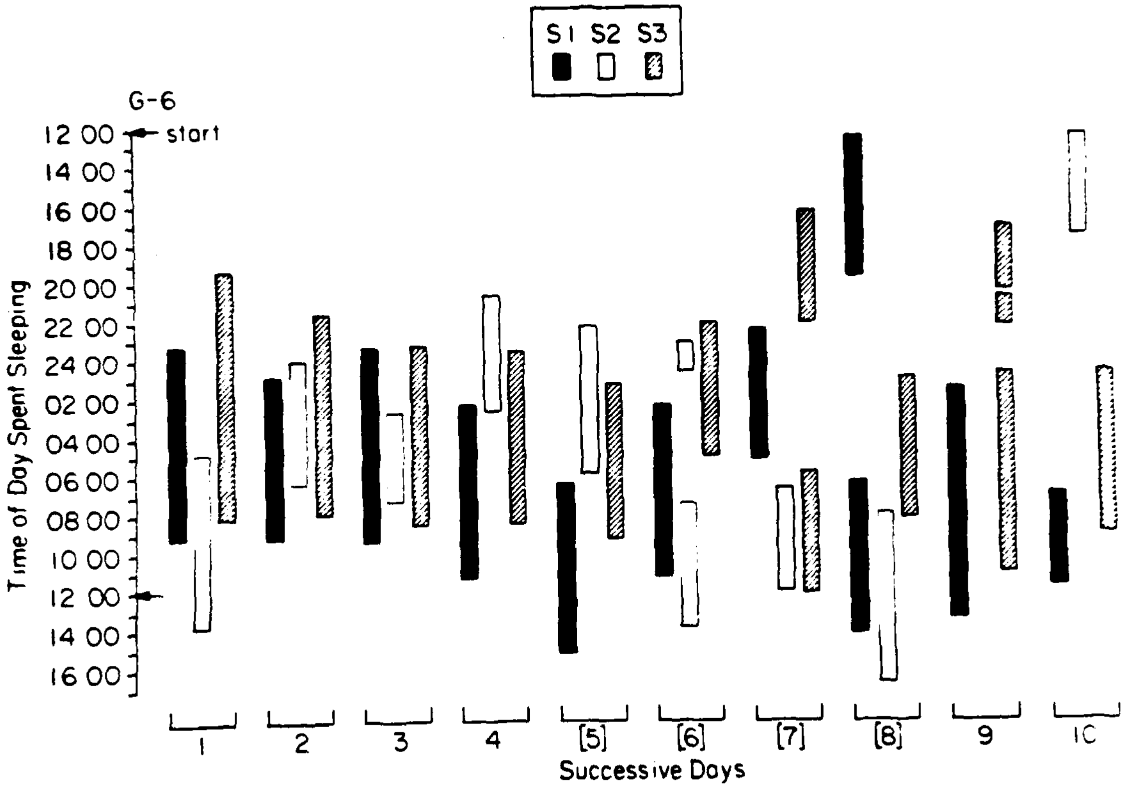


Figure 37. Time of day spent sleeping for all subjects in G6 across successive days of the experiment. Bracketed Days 5-8 were 3-person days. A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show sleep periods that persisted across the boundary between successive days.

show an abrupt return to a typical day-night orientation. Importantly, S2, the novitiate in G4, did not maintain his wake-sleep cycles over succesive experimental conditions as he was observed to do when he was a member of G4.

Figure 38 presents mean interpersonal ratings for all subject pairs in G6 across successive days of the experiment. Only sporadic departures from a "1" rating were observed (e.g., S1, Day 1; S2, Day 9; S3, Day 5).

Figure 39 presents social activity durations for all subjects within G6 across successive days of the experiment. Bracketed Days 5-8 were triadic days. Social episodes occurred on 7 of the 10 days. During 3-person Days 5-8, both triadic and dyadic episodes occurred on 3 of the 4 days. The novitiate engaged in 2 dyadic episodes with S2 but no dyadic episode with S1.

An analysis of testosterone obtained from total urine volumes collected throughout the experiment was notable for the absence of large-magnitude changes across successive experimental conditions. As shown in Figure 40, S1 showed levels consistently intermediate across successive experimental days. Importantly, these levels were similar to those observed when he was a participant in G4 (see Figure 28). Subject 2, the novitiate in G4 who showed marked elevations in testosterone when he joined the group, failed to show comparable elevations when the female novitiate joined the group on Day 5. Significantly, in the present experiment, S2 did not maintain his established wake-sleep cycles as he was observed to do when he was a member of G4. Subject 3, the female

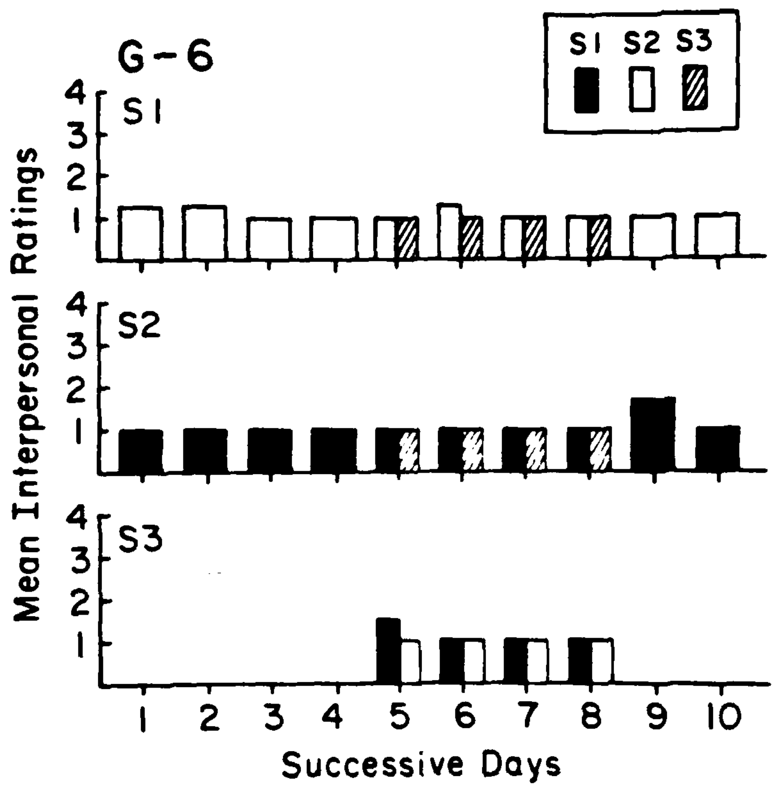


Figure 38. Mean interpersonal ratings for all subject pairs in G6 across successive days of the experiment. 1 = not bothered by a subject, and 4 = extremely bothered.

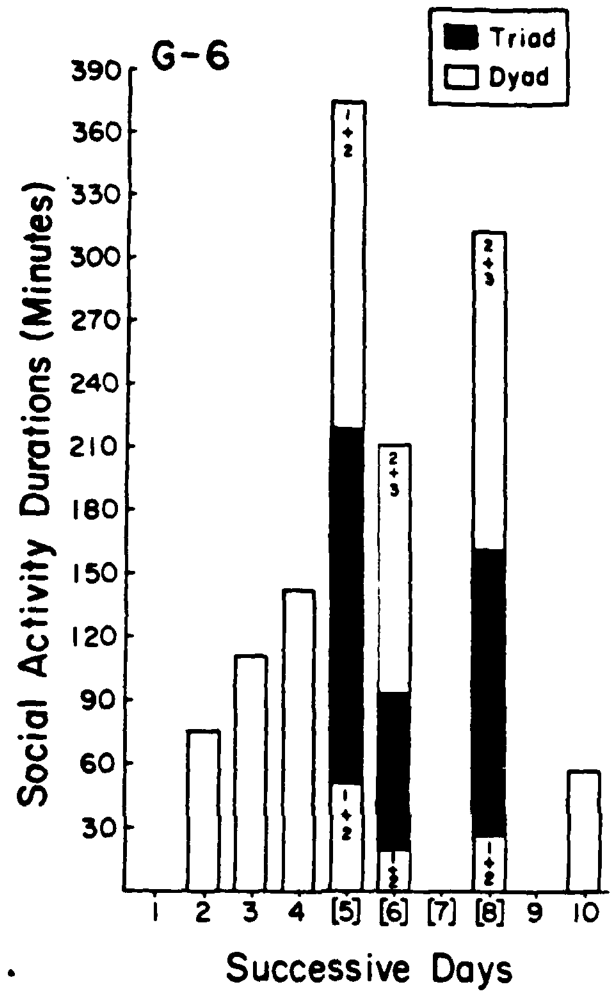


Figure 39. Social activity durations for all subjects in G6 across successive days of the experiment. The order of a social episode within a day is indicated by successive ordinal positions above the abscissa. Numbers within open bars denote pair members composing a dyadic episode. Bracketed Days 5-8 were 3-person days.

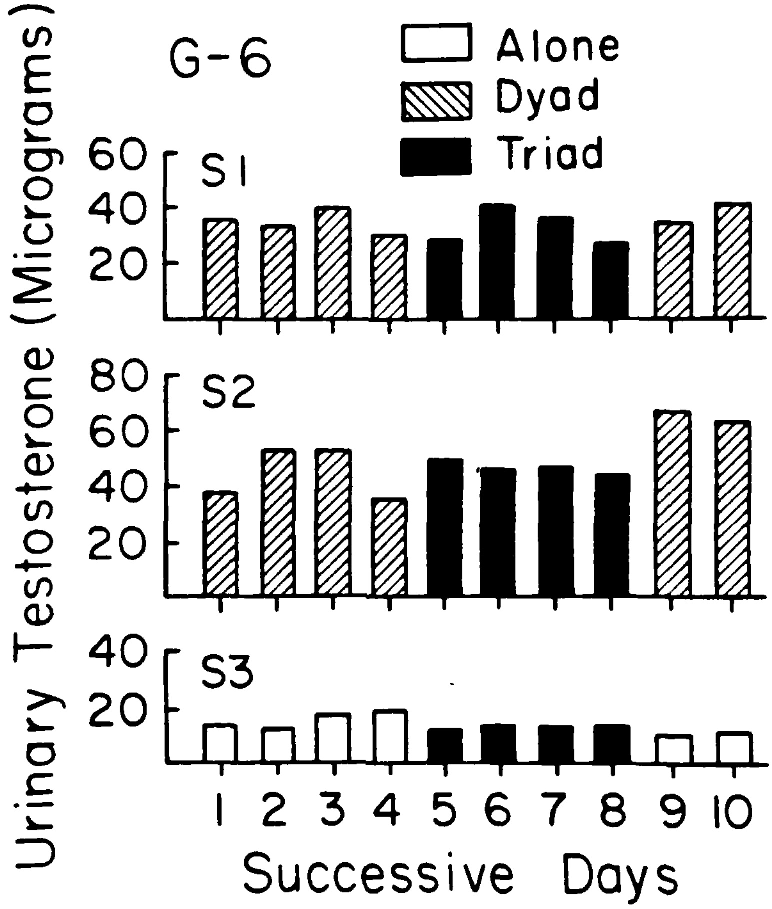


Figure 40. Total urinary testosterone for all subjects in G6 across successive days of the experiment.

novitiate, showed a slight drop in testosterone across Days 5-8 in comparison to levels observed during baseline Days 3-4. Finally, given the erratic character of subjects' work intervals and wake-sleep cycles that contrast with the relative constancy of the hormonal measures, these data suggest that this particular group failed to resolve issues of leader-follower relationships that might have otherwise been reflected in the endocrine domain.

REPLACEMENT EFFECTS

The next series of 4 experiments demonstrated the extension of the research paradigm from analyses of "introduction" effects to the analysis of "replacement" effects (Emurian, Brady, Meyerhoff, and Mougey, 1983). Whereas the previous investigations changed group size as an experimental variable or treatment, the next series of studies held group size constant to evaluate effects of replacing a member of an established 3-person group with a novitiate participant. These replacement analyses, then, involved important elements of continuity with the preceding studies in the manner of being systematic replications of those investigations. In a research strategy based upon systematic replications, as compared with exact or direct replications, effects of the experimental variable or treatment are demonstrated by affirming the consequent (Sidman, 1960), in which case each successive replication incrementally contributes to an understanding of effects that can be reliably attributable to the antecedent condition (*e.g.*, introductions or replacements). The generality of the behavioral processes is assured by showing similar relationships across a broad range of circumstances (*e.g.*, subjects, order and duration of experimental

conditions, performance tasks, group size, etc.). This research strategy has proven to be most productive and economical, especially in light of the expense and staffing effort required to undertake programmed environment investigations.

A typical replacement investigation proceeded as follows. An original 3-person group resided in the programmed environment for 5 successive days. At the end of Day 5, one of the original group members was withdrawn, and he was replaced by a novitiate participant who, along with the remaining 2 original members, formed a new group for the next 5 successive days. Consecutive studies differed in terms of (1) the decision rule by which an original group member was withdrawn, (2) the number of baseline days that came before group formation, and (3) the type of performance tasks that the group members operated for compensation.

R1: Replacement with Individual Task

For the first replacement experiment (R1), 3-person group members resided in their private rooms for a 2-day baseline "alone" period (Days 1-2) during which time access to the intercom, to social activities, and to the MTPB work station was prohibited. This 2-day period provided a necessary hormonal reference against which to assess endocrine responses in relationship to initial group formation. On Days 3-5, all activities previously prohibited were made available to the group, and each member was required to operate the MTPB for individual compensation. As in the introduction experiments, there was only one MTPB console located within the workshop, and subjects occupied the workshop singly on a

self-determined rotational basis. This procedure, then, permitted an evaluation of the manner in which subjects occupied the work station (e.g., duration of work periods, time-of-day of work periods, etc.) as one of the principal dependent variables of the experiment.

At the end of Day 5, whoever of the 3 mission members had earned the fewest MTPB performance points, totalled across Days 3-5, was withdrawn from the experiment. This decision rule was known by the group members before the experiment began. The novitiate participant entered the programmed environment on Day 6, which was a solitary baseline day for all 3 subjects. On Day 7, the newly formed team had access to intercom communications, social activities, and the MTPB work station that continued to be available throughout Days 7-10. Thus, the two 10-day participants were required to adjust to the replacement of an original member, and the novitiate member was required to adjust to his entrance into an established unit whose members shared a history of having competed successfully to maintain high levels of performance effectiveness.

Figure 41 presents cumulative performance points for all subjects within R1 across successive "work" days of the experiment. These data show that, at the end of Day 5, S2 was the low point earner in the original group, and he was withdrawn at the end of Day 5. When the group was reformed on Day 7, all subjects worked thereafter on Days 7-10. During that 4-day period, S3 continued to show the highest daily point accumulations, and S4, the novitiate, showed the lowest cumulative points at the end of Day 10.

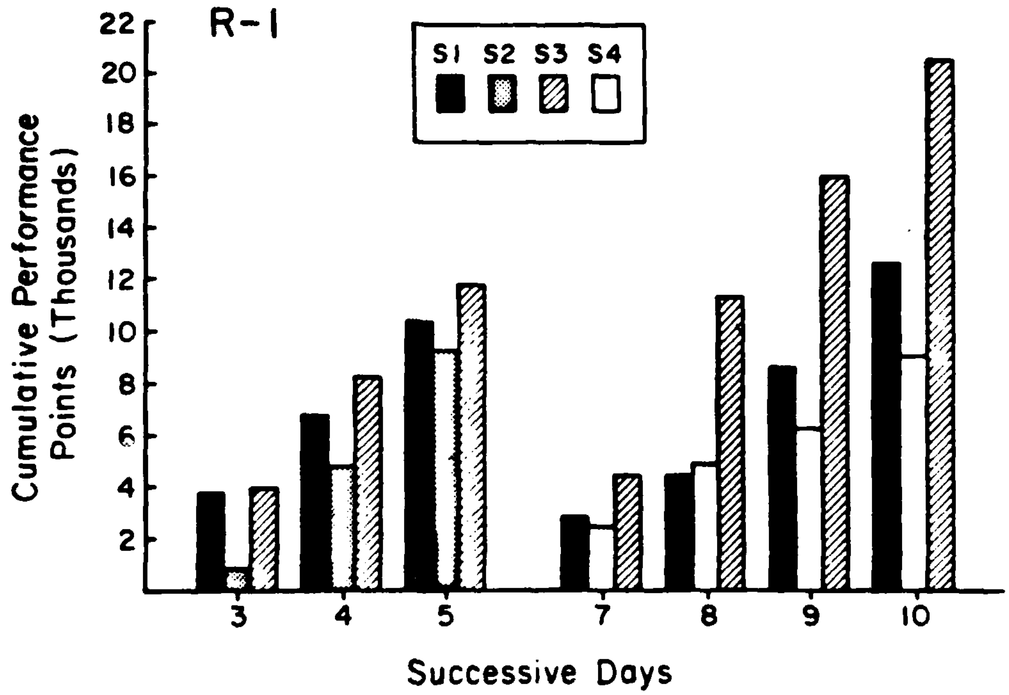


Figure 41. Cumulative performance points for all subjects in R1 across successive days of the experiment. Days 1-2 and Day 6 were baseline "alone" days.

<u>Figure 42</u> presents time of day spent working on the MTPB for all subjects within R1 across successive days of the experiment when access to work was permitted. The novitiate participant is identified as "S4." Throughout Days 3-5, subjects alternated in their occupancy of the work station, with uninterrupted work periods ranging from 2 hours (<u>e.g.</u>, S1, Day 3) to 9 hours (<u>e.g.</u>, S2, Day 4). The lengthy work period exhibited by S2 on Day 4 was related to his attempt to remain competitive after having worked only 2 hours on Day 3. When the novitiate (S4) began to work on Day 7, having replaced S2, he initially preempted the work station for at least 9 uninterrupted hours of the MTPB performance. Thereafter, the novitiate and the remaining group members alternated occupancy of the work station, with S3 clearly showing work times later in the day in contrast to his work times during Days 3-5. Neither the original group nor the reformed group showed stability across days of work times, and this outcome is perhaps attributable to the competitive contingencies for individual compensation that were present throughout all work days.

<u>Figure 43</u> shows time of day spent sleeping for all subjects across successive days of the experiment. A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show sleep periods that persisted across the boundary between successive days. Comparatively stable sleep patterns were exhibited only by S2 who show uninterrupted sleep episodes beginning between 2400 and 0500 hours across Days 1-5. During the same 5-day period, S2 and S3 almost always showed erratic sleep

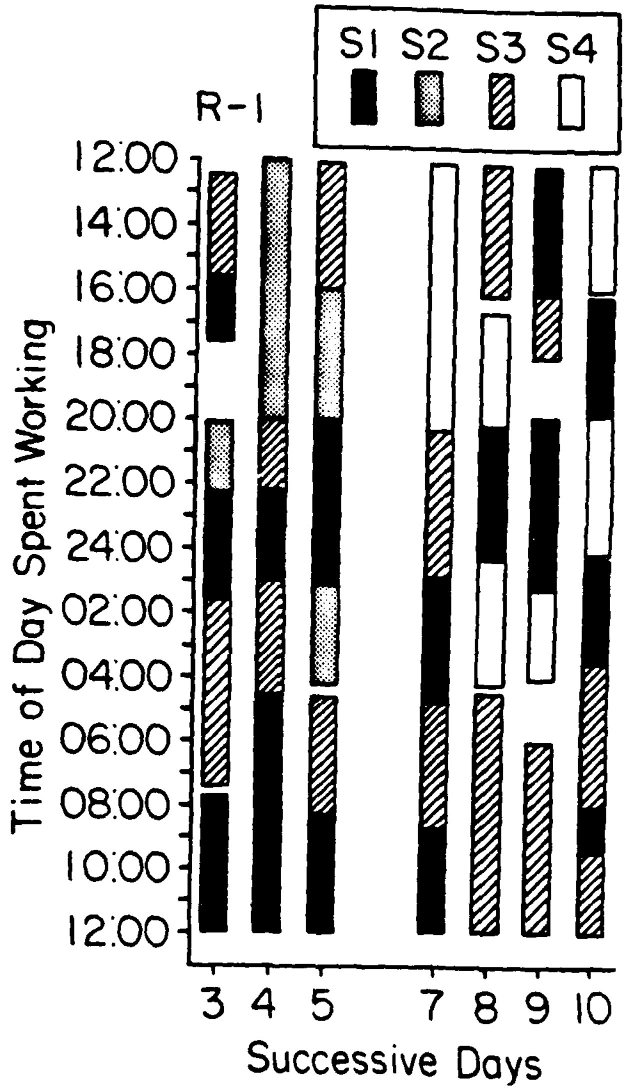


Figure 42. Time of day spent working for all subjects in R1 across successive days of the experiment. Days 1-2 and Day 6 were baseline "alone" days.

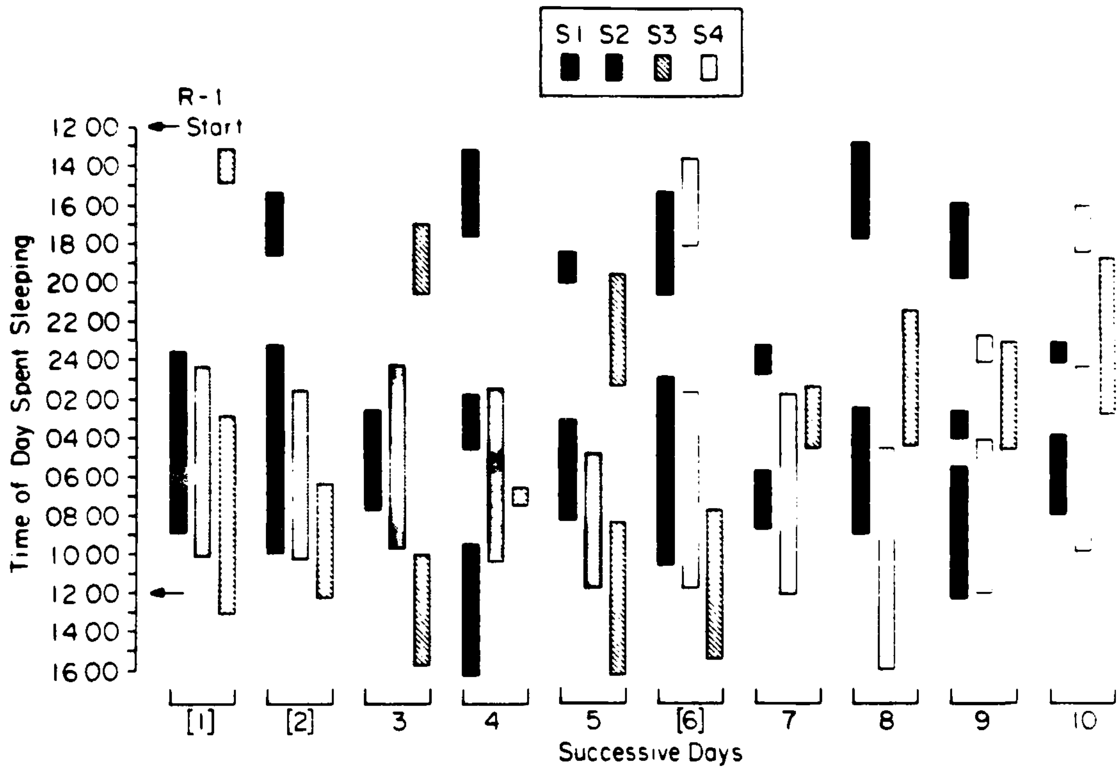


Figure 43. Time of day spent sleeping for all subjects in R1 across successive days of the experiment. Bracketed Days 1-2 and Day 6 were baseline "alone" days. A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show sleep periods that persisted across the boundary between successive days.

episodes that differed across days in the time of day of occurrence, frequency, and duration. Similar erratic patterns persisted during Days 6-10 when S2 was replaced by the novitiate (S4). Importantly, the novitiate showed the most consistent sleep periods across days, and S3 showed a clear reorientation in his sleep episodes that persisted throughout Days 7-10. These latter effects reflect the readjustments that were required by at least 1 original group member when the novitiate became a working participant during Days 7-10 of the experiment.

Figure 44 presents mean interpersonal ratings for all subject pairs within R1 across successive days of the experiment. Bracketed Days 1, 2, and 6 were baseline "alone" days. During Days 3-5 only S3 expressed irritation with other group members. During Days 7-10, however, both S1 and S2 sometimes expressed irritation with the novitiate (S4), and the novitiate sometimes expressed irritation with S1 and S2.

Figure 45 presents social activity durations for all subjects in R1 across successive "work" days of the experiment. Only one 2-hour dyadic episode occurred during the experiment (S1 and S2, Day 3). No triadic episode was observed.

Figure 46 shows total urinary testosterone for all subjects across successive days of the experiment. With respect to the original group members, S2 showed testosterone levels that were somewhat lower than the

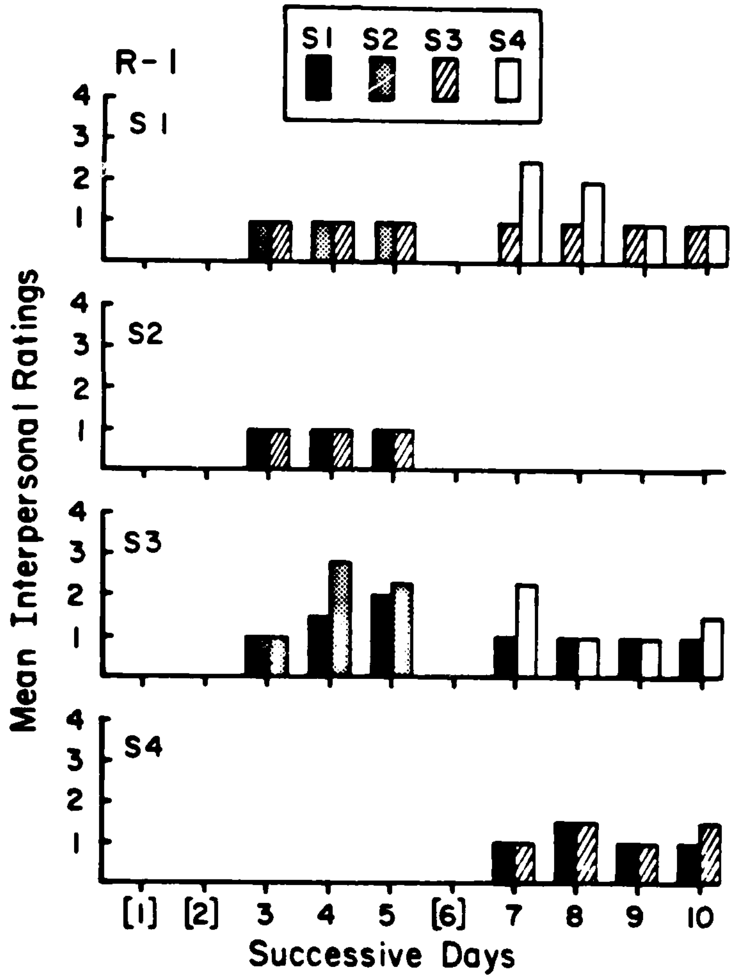


Figure 44. Mean interpersonal ratings for all subject pairs in R1 across successive days of the experiment. Bracketed Days 1-2 and Day 6 were baseline "alone" days. 1 = not bothered by a subject, and 4 = extremely bothered.

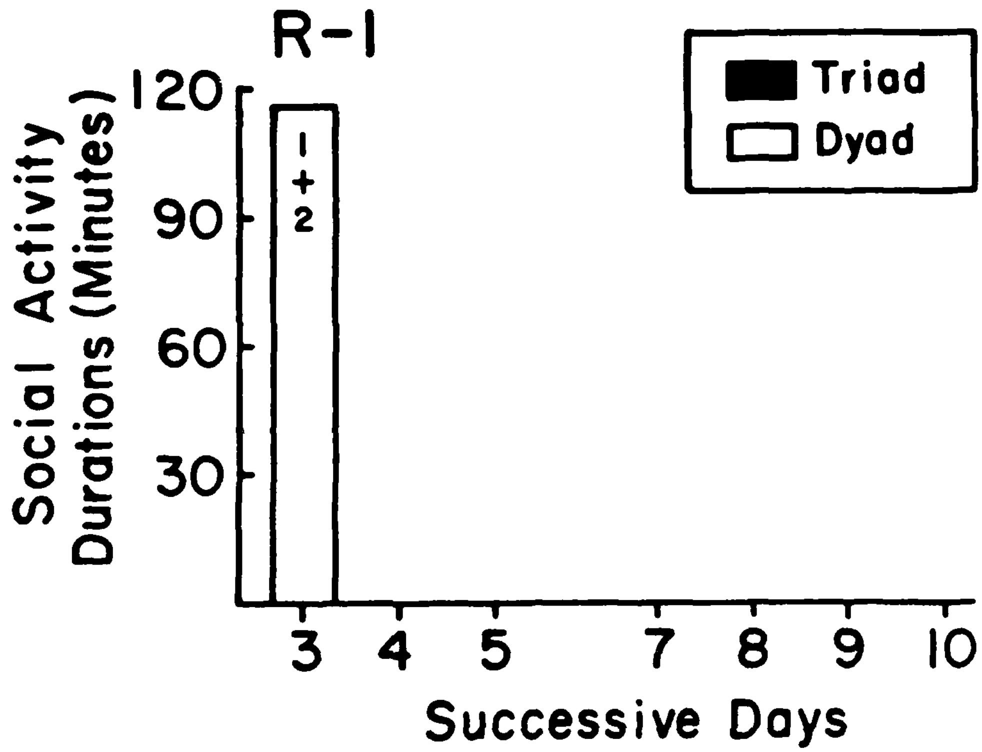


Figure 45. Social activity durations for all subjects in R1 across successive days of the experiment. Numbers within open bars denote pair members composing a dyadic episode. Days 1-2 and Day 6 were baseline "alone" days.

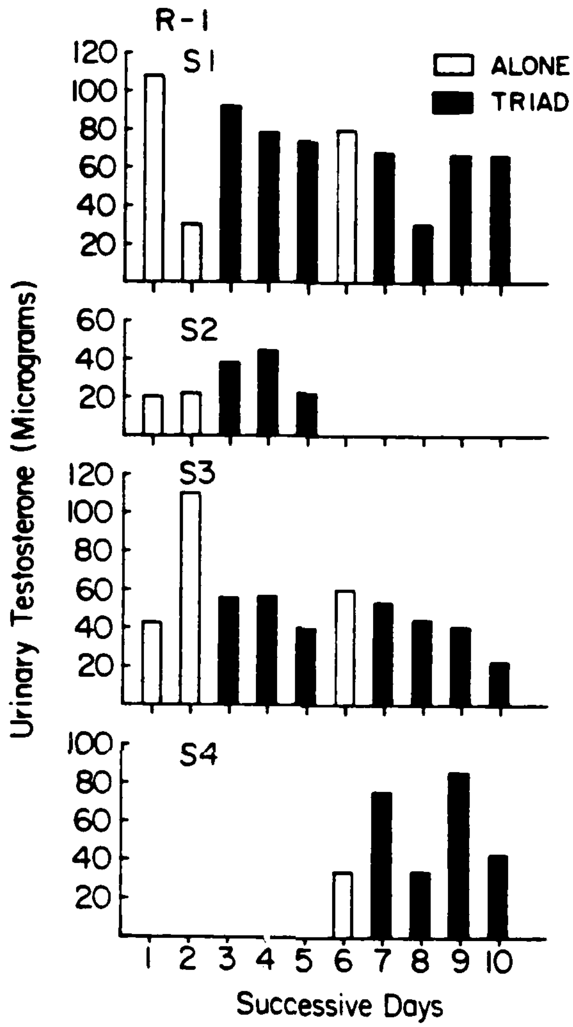


Figure 46. Total urinary testosterone for all subjects in R1 across successive days of the experiment.

other 2 participants. Importantly, these comparatively lower levels were evident during the first 2 baseline days of the experiment. When group members commenced working on Day 3, S2's levels increased somewhat over baseline levels, but they continued to be below the levels exhibited by the other 2 members across Days 3-5. Significantly, S2 was the mission member who did not compete successfully to remain within the experiment for 10 days, and he was withdrawn at the conclusion of Day 5. Finally, across Days 7-10, testosterone levels progressively declined for S3 in relationship to his shift in work and sleep times. This latter effect confirms the outcomes observed in the introduction studies, and it demonstrates, by systematic replication, the generality of the behavioral-biological processes governing such effects.

R2: Replacement with Individual Task

The experimental design plan of the second replacement analysis (R2) was similar to the first with 2 major differences. First, the novitiate group member was a female who had previously participated in an unrelated 10-day residential experiment, and she had almost 60 hours' practice on the MTPB. Second, to provide more days for competition to remain in the experiment and a longer history of sustained performance effectiveness by 2 group members prior to the novitiate's entrance, no initial baseline was programmed. The novitiate, then, was scheduled to enter the environment at the beginning of Day 6, which was a baseline day for all subjects, with more experience in the laboratory than the 2 other group members. Thus, the two 10-day participants were required to adjust to the replacement of an original group member by a person having extensive programmed

environment experience.

Figure 47 presents cumulative performance points by all subjects in R2 across successive "work" days of the experiment. The novitiate participant is identified as "S4." By the end of Day 3, intersubject variability in performance points was more pronounced by subjects in R2 in comparison to the third work day (Day 5) by subjects in R1. Subject 3 in R2 voluntarily withdrew from the experiment during Day 3, reasoning that his performance would not result in his participation beyond Day 5. Since the novitiate was not scheduled to appear until Day 6, a baseline day for all subjects, the 2 remaining subjects were programmed with baseline days on Days 4 and 5. This preserved the integrity of the experimental design plan in relationship to analyses of 3-person working groups. Days 7-10, with the novitiate S4 as a group member, are characterized by high productivity and low intersubject variability in performance points.

Figure 48 presents time of day spent working on the MTPB for all subjects across successive days of the experiment when access to work was permitted. The novitiate participant is identified as "S4." Throughout Days 1-3, subjects alternated occupancy of the work station in an erratic fashion within and across days, with work periods lasting between 1 hour (e.g., S1, Day 1) and 8 hours (e.g., S1, Day 3). In striking contrast to work times during Days 1-3, work times during Days 7-10 were orderly and precise. The pattern for Day 8 is identical to Day 7, and the pattern for Day 10 is identical to Day 9. Throughout Days 7-10, all subjects occupied the work station for 8 hours each day. These data show the impact of an experienced person, who exhibited assertiveness and leadership, on an

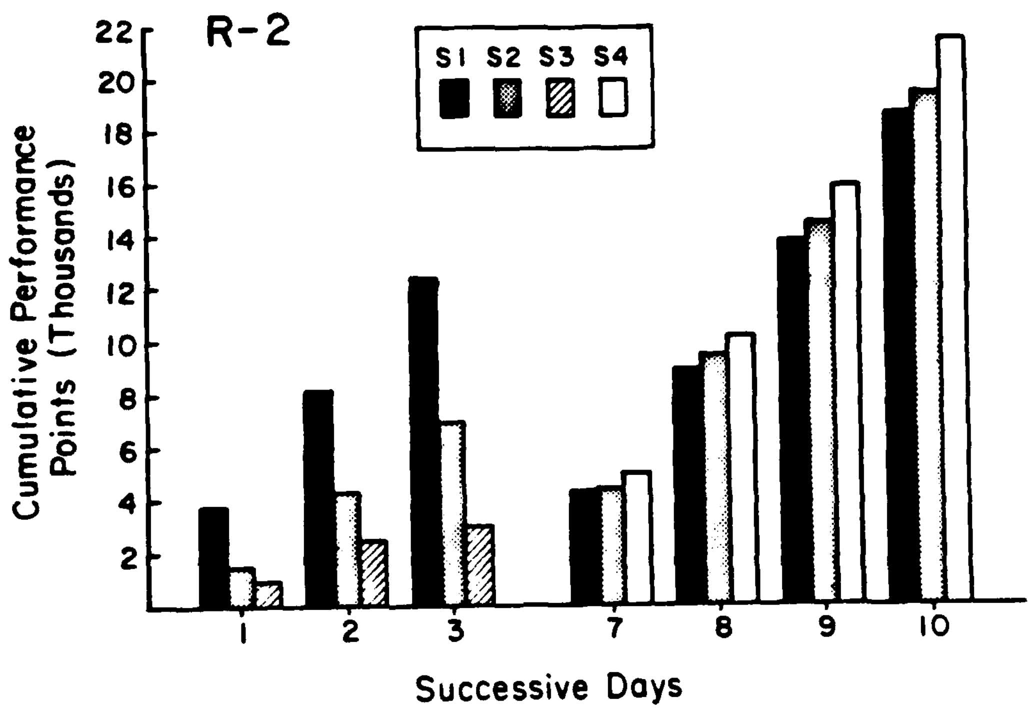


Figure 47. Cumulative performance points for all subjects in R2 across successive days of the experiment. Days 4-6 were baseline "alone" days.

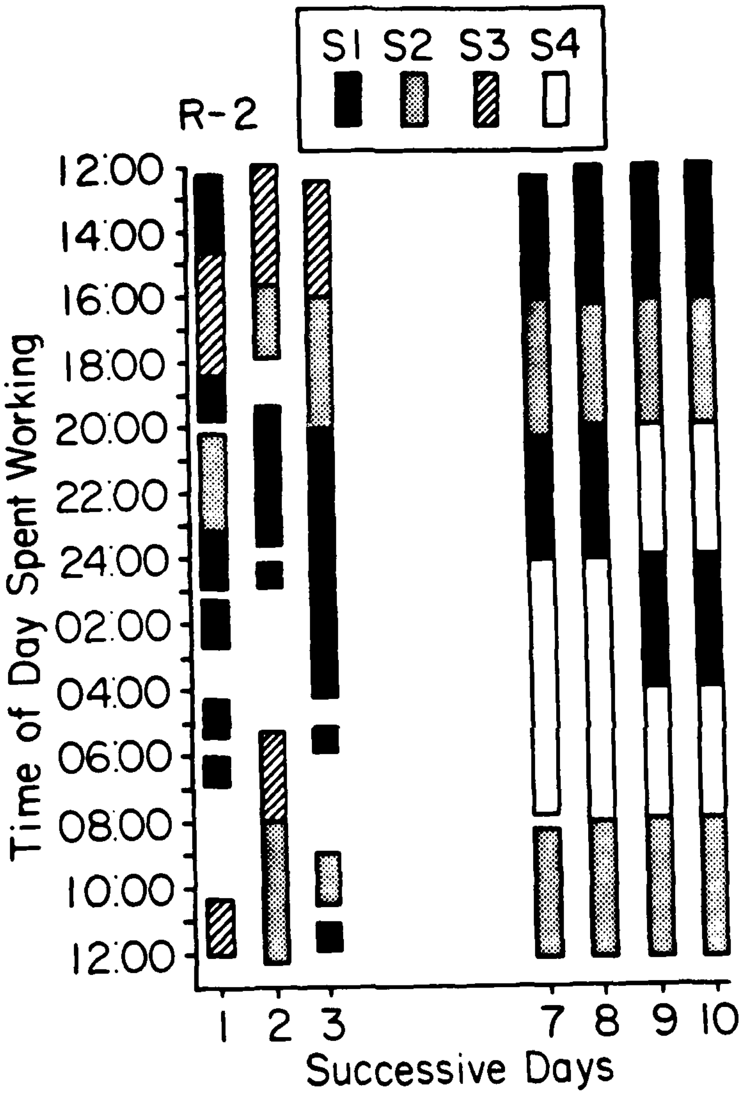


Figure 48. Time of day spent working for all subjects in R2 across successive days of the experiment. Days 4-6 were baseline "alone" days.

established group whose members had previously competed successfully to remain within the experiment.

Figure 49 presents time of day spent sleeping for all subjects across successive days of the experiment. A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show sleep periods that persisted across the boundary between successive days. Although sleep times were perhaps not as erratic as those in the previous experiment, only S2 showed patterns that were somewhat consistent across days. Additionally, the novitiate shifted her sleep pattern on Day 8, and she thereafter commenced sleep periods in the early hours (*e.g.*, 1200) of an experimental "day."

Figure 50 presents mean interpersonal ratings for all subject pairs in R2 across successive days of the experiment. Bracketed Days 4, 5, and 6 were baseline "alone" days. During Days 1-3, S3 received negative ratings by S1 (Days 2 and 3) and S2 (Days 1 and 2). During Days 7-10, S1 and S2 assigned negative ratings to the novitiate (S4), and S4 assigned negative ratings to S1 and S2.

Figure 51 presents social activity durations for all subjects within R2 across successive "work" days of the experiment. Only on Day 2 did the original group members socialize. One 50-min triadic episode occurred, and 2 dyadic episodes with S3 were observed. In contrast, during Days 7-10, only one 60-min dyadic social episode was observed (Day 7), and that episode involved the novitiate.

Figure 52 presents total urinary testosterone for all subjects within

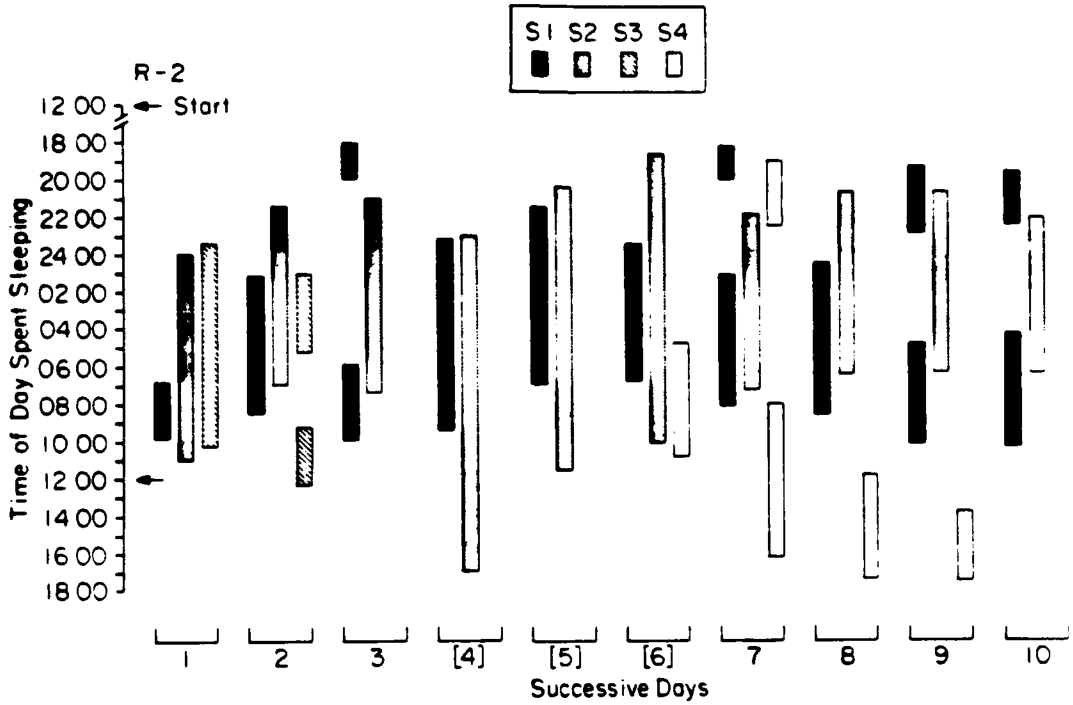


Figure 49. Time of day spent sleeping for all subjects in R2 across successive days of the experiment. Bracketed Days 4-7 were baseline "alone" days. A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show sleep periods that persisted across the boundary between successive days.

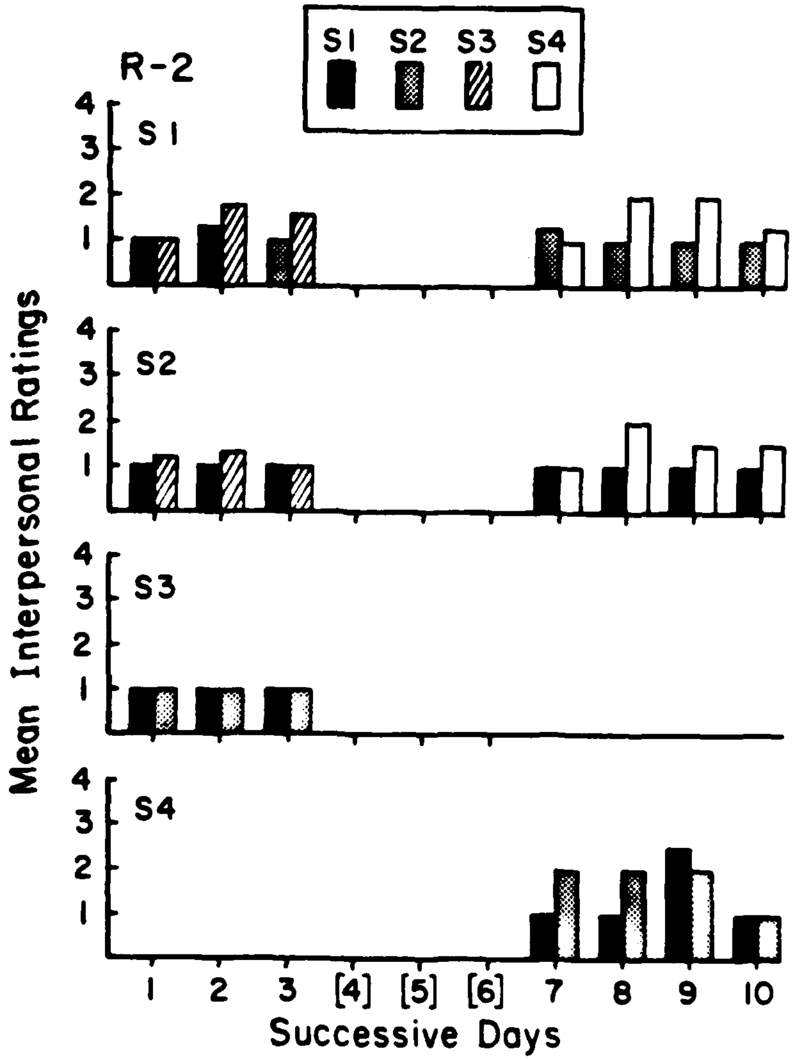


Figure 50. Mean interpersonal ratings for all subject pairs in R2 across successive days of the experiment. Bracketed Days 4-6 were baseline "alone" days. 1 = not bothered by a subject, and 4 = extremely bothered.

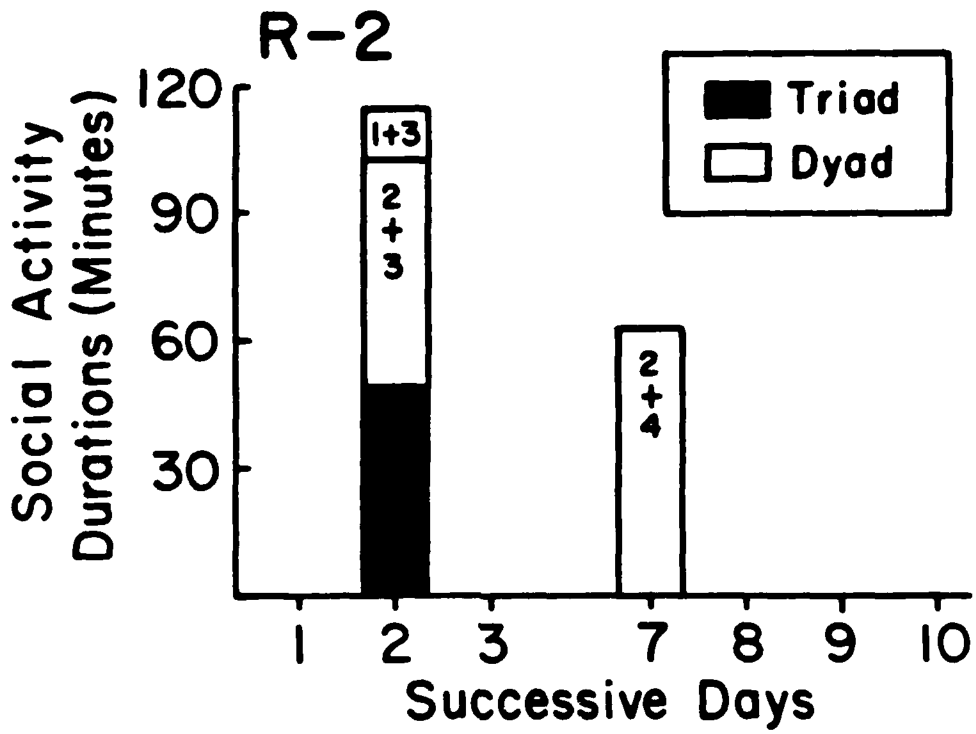


Figure 51. Social activity durations for all subjects in R2 across successive days of the experiment. The order of a social episode within a day is indicated by successive ordinal positions above the abscissa. Numbers within open bars denote pair members composing a dyadic episode. Days 4-6 were baseline "alone" days.

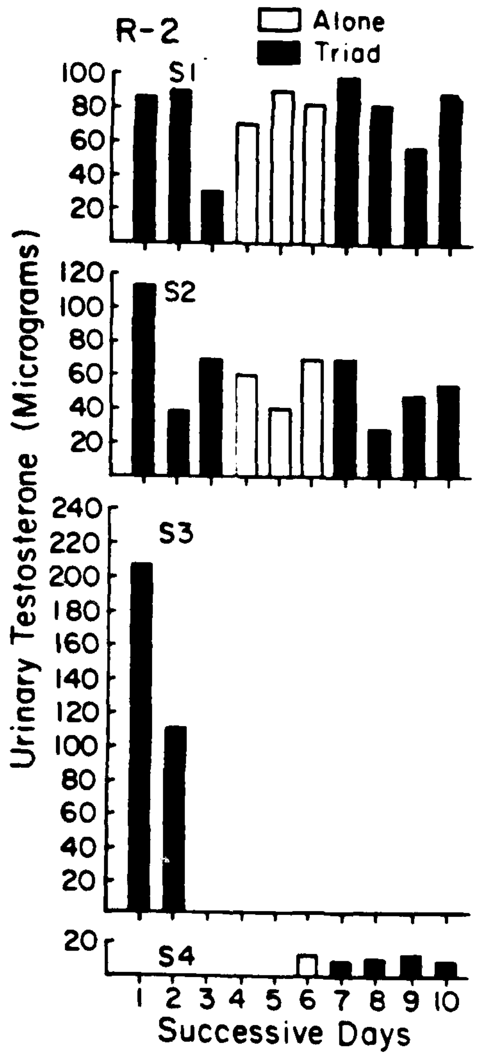


Figure 52. Total urinary testosterone for all subjects in R2 across successive days of the experiment.

R2 across successive days of the experiment. Subject 3, the participant who voluntarily withdrew, showed a pronounced drop in testosterone levels between Days 1 and 2.

<u>R3 and R4</u>: <u>Replacement with Team Task</u>

In all previous introduction and replacement investigations, the coordination required of group participants was reflected in the sequential use of the work station and in the program synchrony necessary for subjects to meet together in the recreation room for social episodes. In the next replacement investigations (R3 and R4), however, the team performance task (TMTPB) was introduced into the research protocol that systematically replicated the preceding analyses with a task demanding temporally coordinated performances among group participants.

Each 10-day experiment began with a 3-man team whose members were new to the programmed environment and to the TMTPB. Participants had been acquainted with the <u>individual</u> MTPB during an orientation session, but acquisition of the TMTPB occurred for the first time on Day 1 of the experiment. For remuneration for participation, the team was permitted to accumulate up to 5000 accuracy points each day, requiring 6-9 hours of work to accomplish. The group members decided among themselves the manner of distributing the performance demands of the individual and team subtasks.

At the end of Day 5, one of the 3 original team members was withdrawn from the experiment. Initial group members began the study with the understanding that 1 participant would be withdrawn, but they were not given the decision rule by which that choice would be made. At the

beginning of Day 6, then, a novitiate participant was introduced into the programmed environment. To accommodate this transition, the 3 participants followed the behavioral program in their private quarters on Day 6, but without access to the TMTPB, intercom communications, and social activities. On Day 7, the novitiate member joined the group as the replacement participant, and this newly formed team operated the TMTPB on Days 7-10.

In R3, the subject chosen for removal was an effective team participant as evidenced by his structuring of the work periods and by his encouragement to reach the daily performance ceiling. In R4, however, it became clear over Days 1-5 that one of the 3 original group members was seriously compromising the team's attempts to reach asymptotic performance, and it was only prudent to withdraw that "ineffective" participant at the conclusion of Day 5. This unforseen circumstance, then, afforded the opportunity to assess replacement effects when both an "effective" and an "ineffective" team participant was replaced.

Figure 53 shows total (i.e., team plus individual) TMTPB performance points by subjects within R3 and R4 across successive days of the experiment. Members in R3 never failed to reach the daily performance ceiling (i.e., 5000 points). In contrast, the original team in R4 never reached the performance ceiling during Days 1-5. Performance productivity abruptly improved on Day 7 when an ineffective member was replaced, and it declined thereafter across successive days.

Figures 54 and 55 show individual and team task performance,

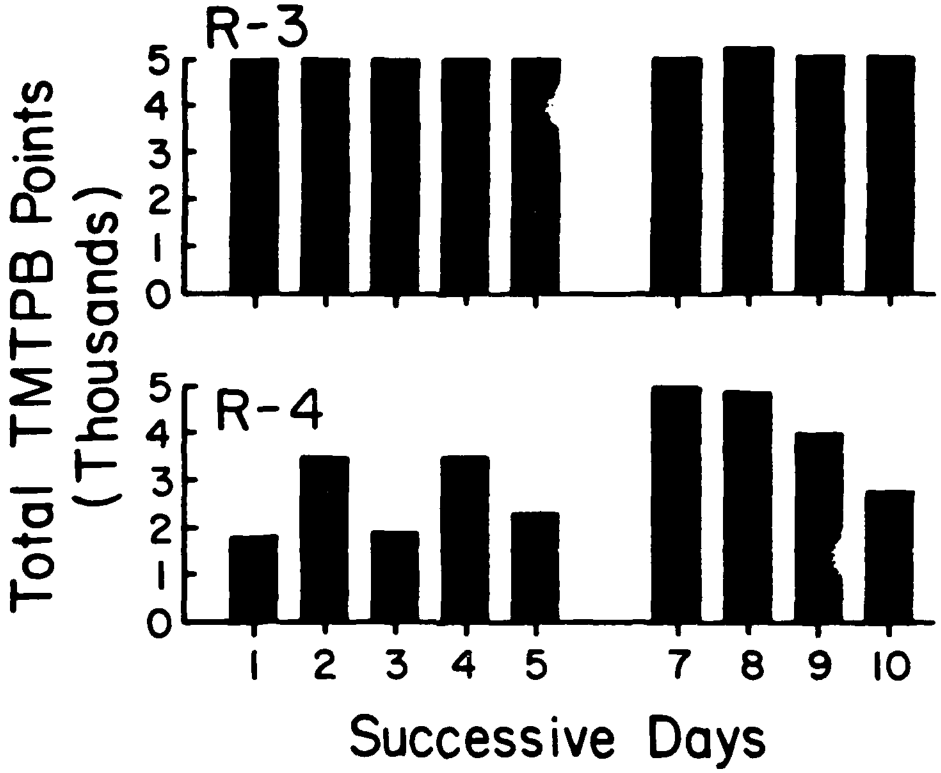
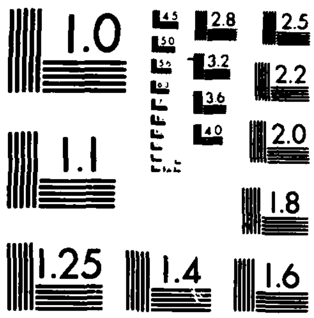


Figure 53. Total (team plus individual) TMTPB performance points by subjects in R3 and R4 across successive days of the experiment. Day 6 was a baseline "alone" day.

AD-A141 561 BEHAVIORAL AND BIOLOGICAL EFFECTS OF CHANGES IN GROUP SIZE AND MEMBERSHIP(U) JOHNS HOPKINS UNIV BALTIMORE MD DEPT OF PSYCHIATRY H H EMURIAN ET AL. 01 JUN 84 2/2

UNCLASSIFIED TR-ONR-10 N00014-80-C-0467 F/G 5/10 NL

END
DATE
FILMED
7-84
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

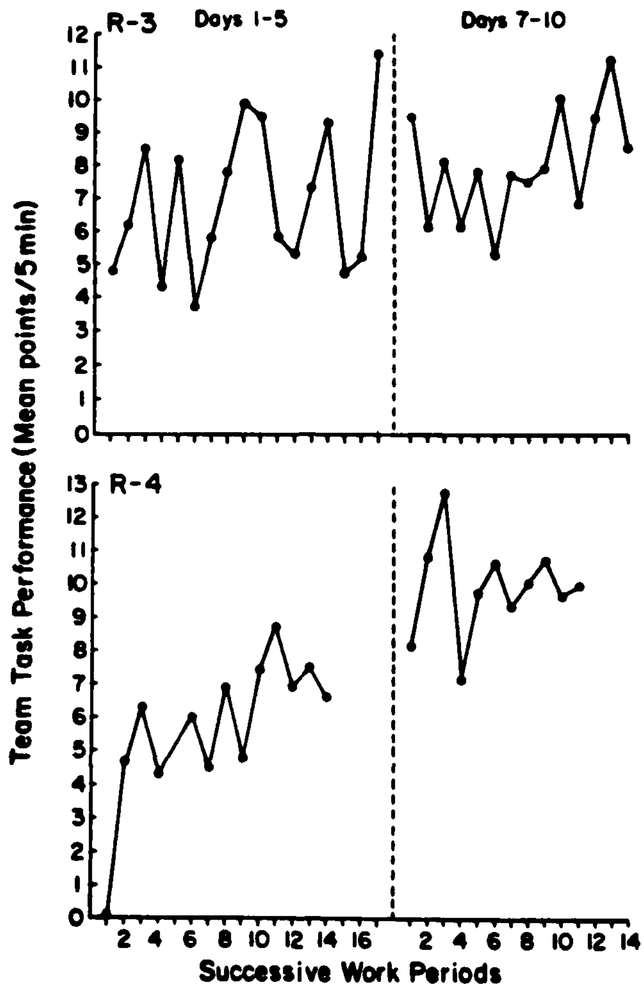


Figure 55. Team task performance for subjects in R3 and R4 across successive work periods.

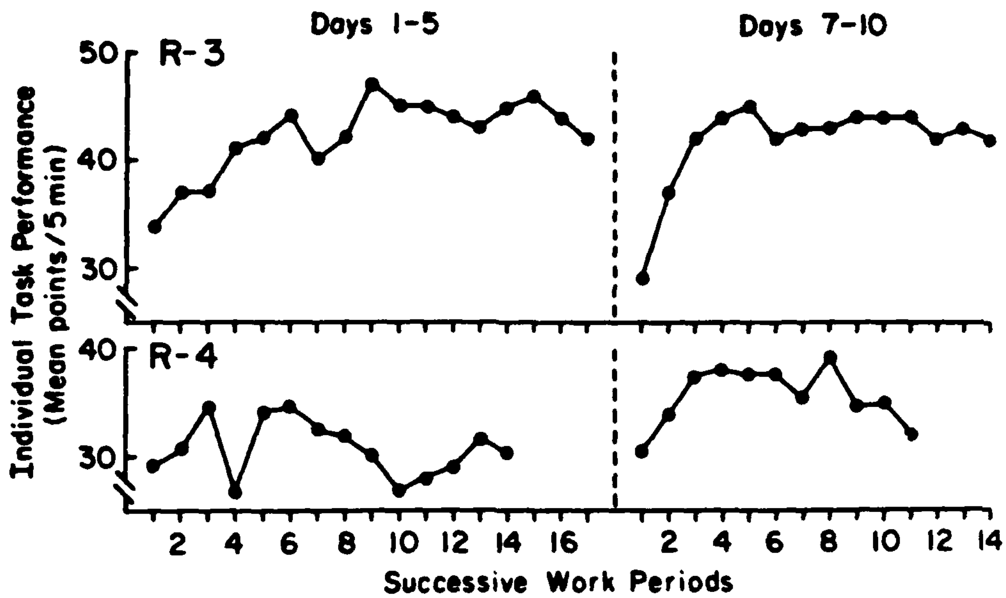


Figure 54. Individual task performance for subjects in R3 and R4 across successive work periods.

respectively, across successive work periods for R3 and R4. For R3, individual acquisition was smooth as was reacquisition following performance degradation when a group member was replaced by a novitiate. For R4, the presence of an "ineffective" original group member prevented transition to asymptotic performance that was partly realized when that member was replaced. In contrast, both R3 and R4 showed progressive improvement on the team subtask across successive work periods. This suggests that the 2 proficient team members in R4 were unable to compensate for an ineffective member, and the extra attention required to maintain adequate performance on the team subtask was revealed by the decrements observed on the individual subtasks.

Figures 56 and 57 present time of day spent working on the TMTPB by subjects in R3 and R4, respectively, across successive days of the experiments. In R3, 3 or 4 work periods occurred each day, and they ranged in duration from 2 to 5 hours. Although the time of day associated with work periods differed across days, work was not generally observed between 2400 and 0800 hours of a day. Finally, the pattern of work that the initial team adopted was also observed during the final 4 days of the study with the reformed team. For R4, time of day spent working was similar to R3. Two to 4 work periods occurred each day, and they ranged in duration from 1 to 5 hours. The distribution of work periods throughout a "day" was similar to R3, and it was not demonstrably affected by membership replacement.

Figures 58 and 59 present time of day spent sleeping for all subjects within R3 and R4, respectively, across successive days of the experiments.

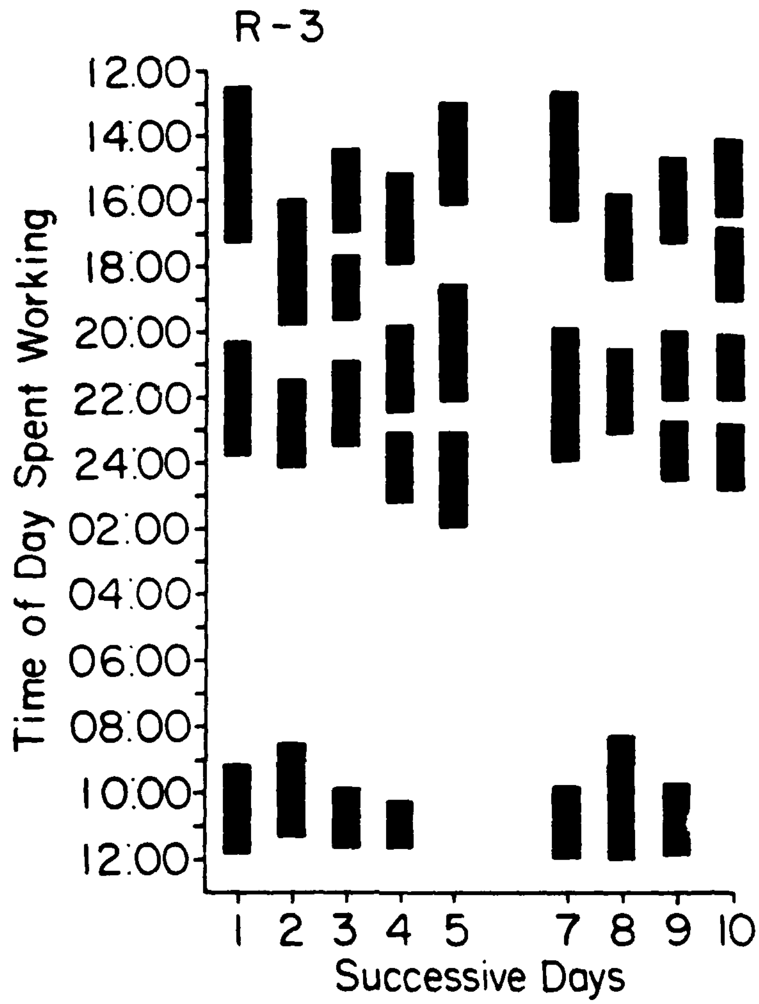


Figure 56. Time of day spent working for subjects in R3 across successive days of the experiment. Day 6 was a baseline "alone" day.

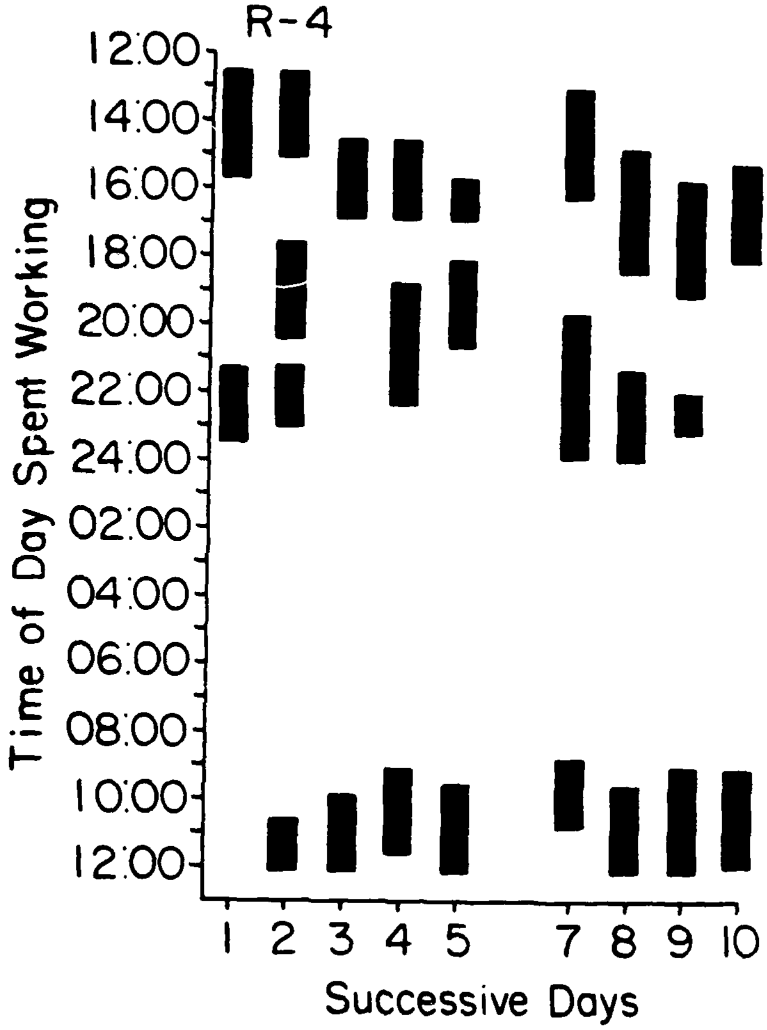


Figure 57. Time of day spent working for subjects in R4 across successive days of the experiment. Day 6 was a baseline "alone" day.

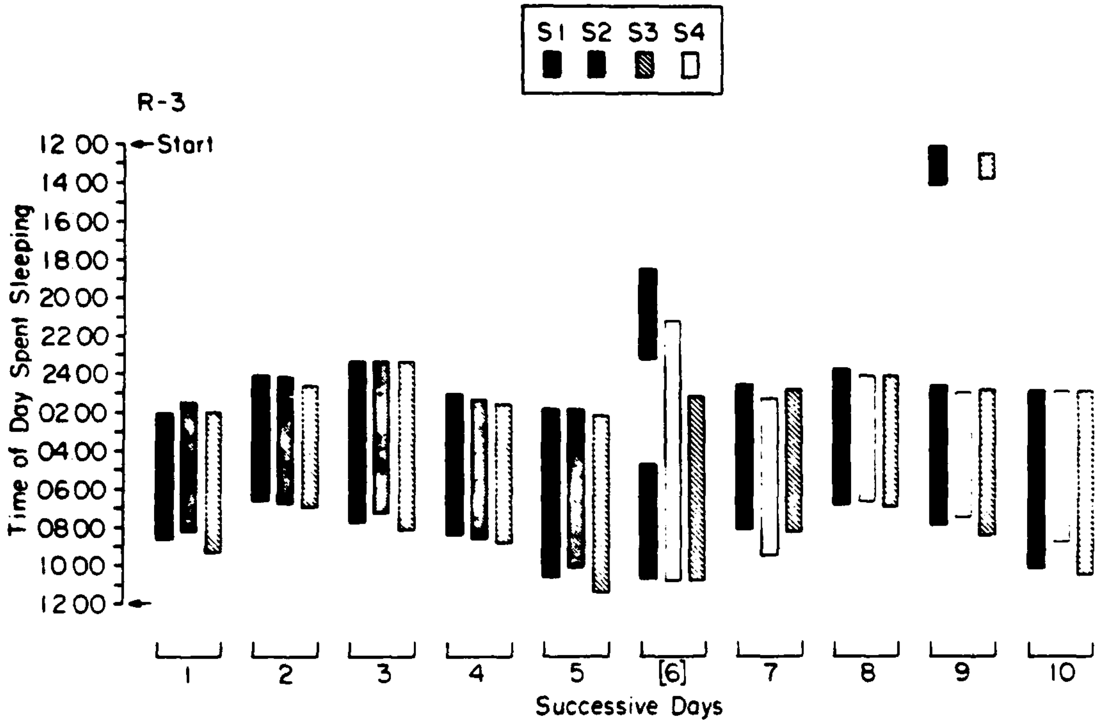


Figure 58. Time of day spent sleeping for all subjects in R3 across successive days of the experiment. Bracketed Day 6 was a baseline "alone" day. A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show sleep periods that persisted across the boundary between successive days.

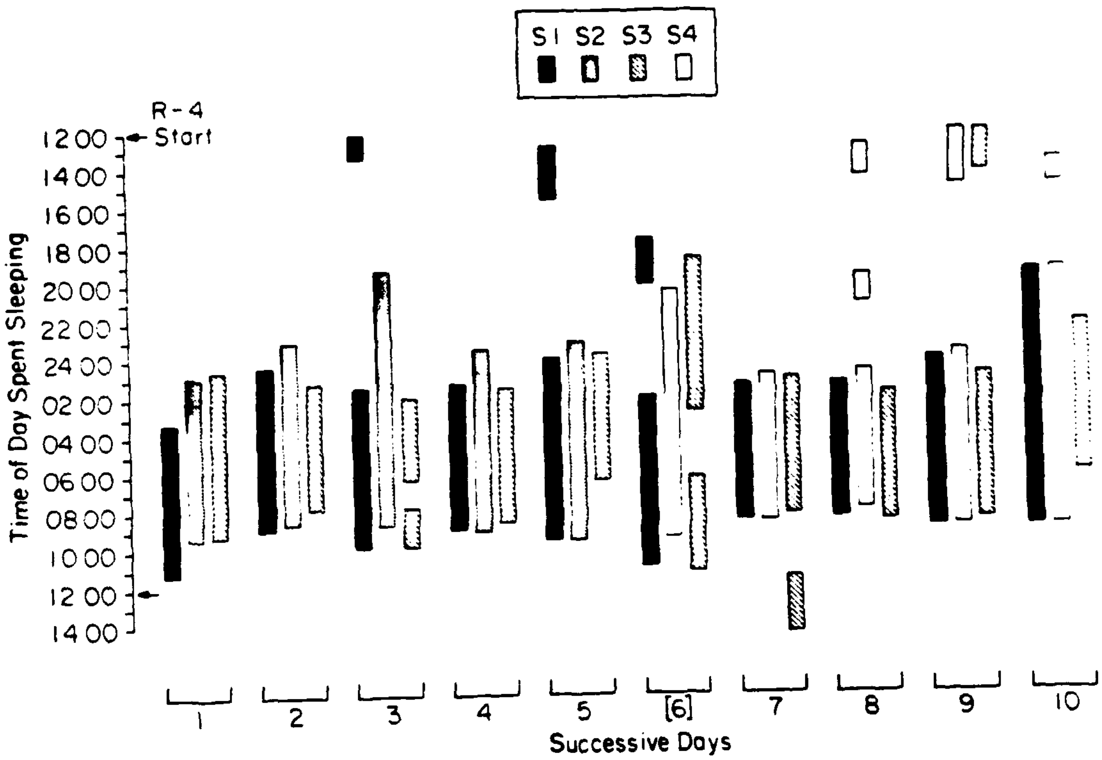


Figure 59. Time of day spent sleeping for all subjects in R4 across successive days of the experiment. Bracketed Day 6 was a baseline "alone" day. A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show sleep periods that persisted across the boundary between successive days.

A "day" is bound by arrows on the ordinate, and the ordinate was extended downward to show sleep periods that persisted across the boundary between successive days. The novitiate participant is identified as "S4." Although the behavioral program was not oriented to time markers, sleep periods were generally stable across successive days for both original and reformed groups in R3 and R4. Few "brief" sleep periods occurred for subjects in R3 in comparison to R4. When drift in sleep onset time occurred across days by subjects in R3, all members of a group drifted in concert with each other.

Figures 60 and 61 present mean interpersonal ratings for all subject pairs within R3 and R4, respectively, across successive days of the experiments. The novitiate is identified as "S4," and bracketed Day 6 was a baseline "alone" day. Ratings by subjects within R3 are notable for the absence of departures from "1" with the exception of S2's ratings of S1 on Day 3. Ratings were not demonstrably affected by the replacement of a group member. In contrast, in R4, S1 and S3 assigned negative ratings to the "ineffective" team participant, especially during Days 3-5. Significantly, in both R3 and R4, the novitiate never received a negative rating nor did he or she assign a negative rating to another participant.

Figures 62 and 63 present social activity durations for subjects within R3 and R4, respectively, across successive days of the experiments. The order of the social episode is indicated by successive ordinal positions above the abscissa. Numbers within open bars denote pair members composing a dyadic episode. The novitiate is identified as "S4."

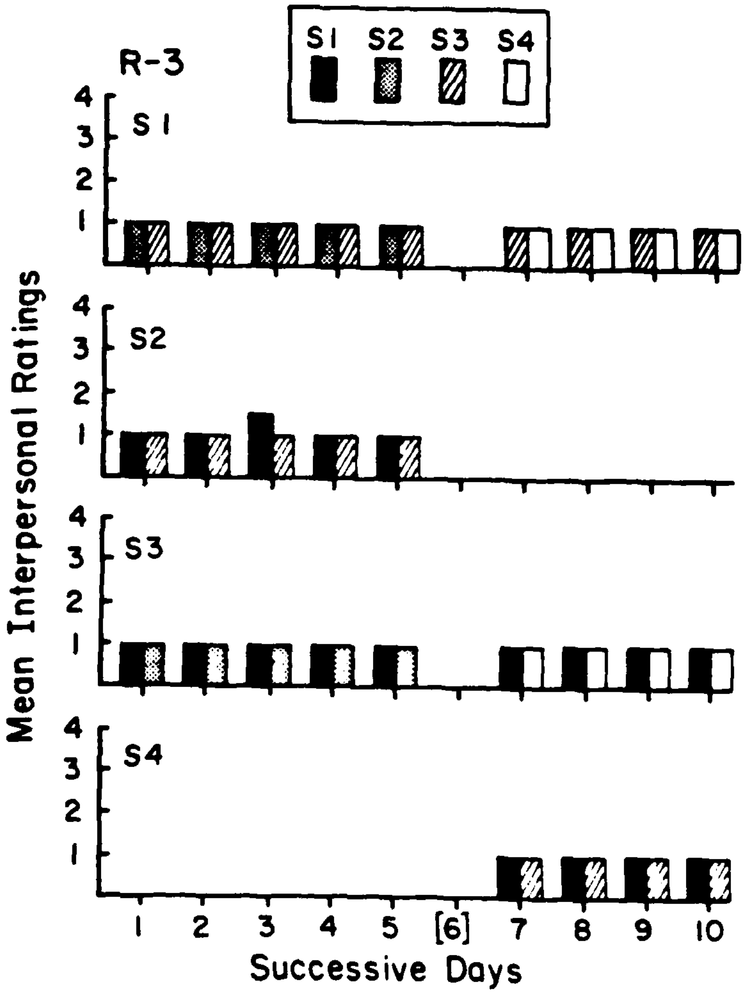


Figure 60. Mean interpersonal ratings for all subject pairs in R3 across successive days of the experiment. Bracketed Day 6 was a baseline "alone" day. 1 = not bothered by a subject, and 4 = extremely bothered.

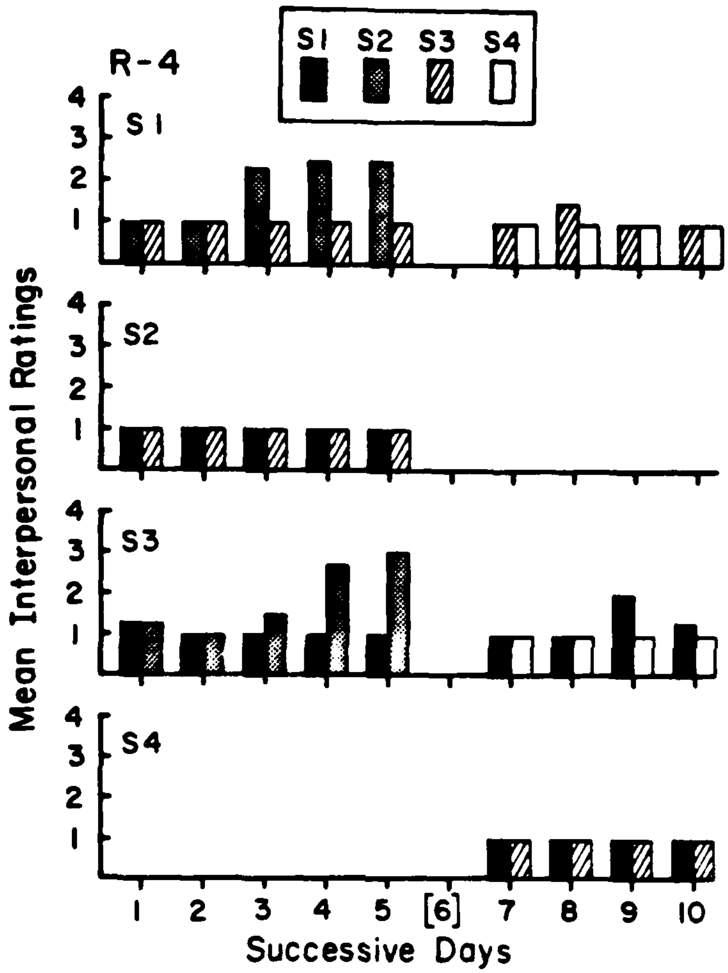


Figure 61. Mean interpersonal ratings for all subject pairs in R4 across successive days of the experiment. Bracketed Day 6 was a baseline "alone" day. 1 = not bothered by a subject, and 4 = extremely bothered.

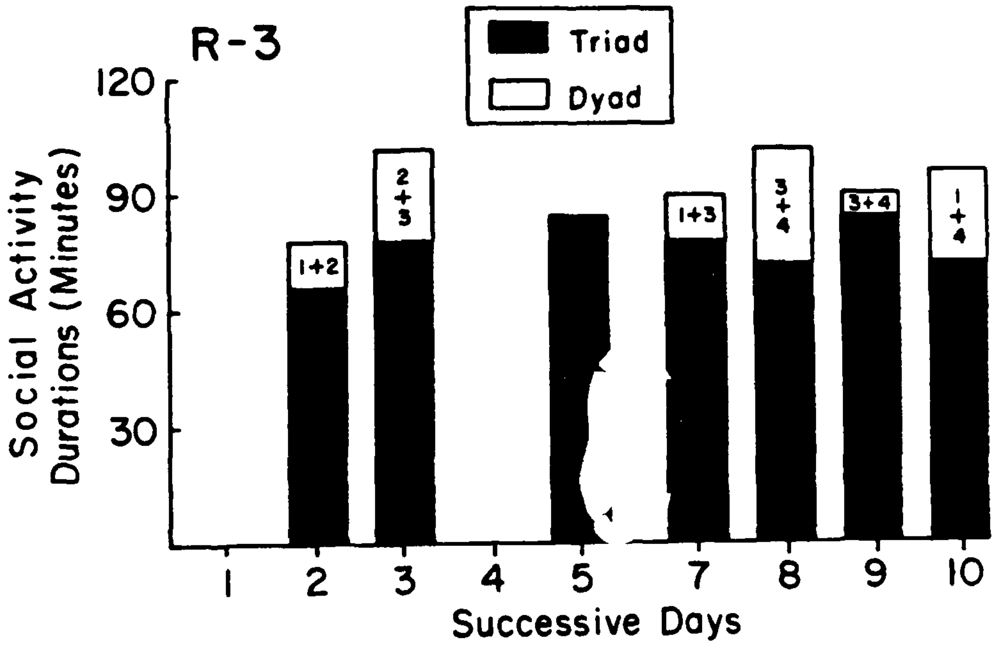


Figure 62. Social activity durations for all subjects in R3 across successive days of the experiment. The order of a social episode within a day is indicated by successive ordinal positions above the abscissa. Numbers within open bars denote pair members composing a dyadic episode. Day 6 was a baseline "alone" day.

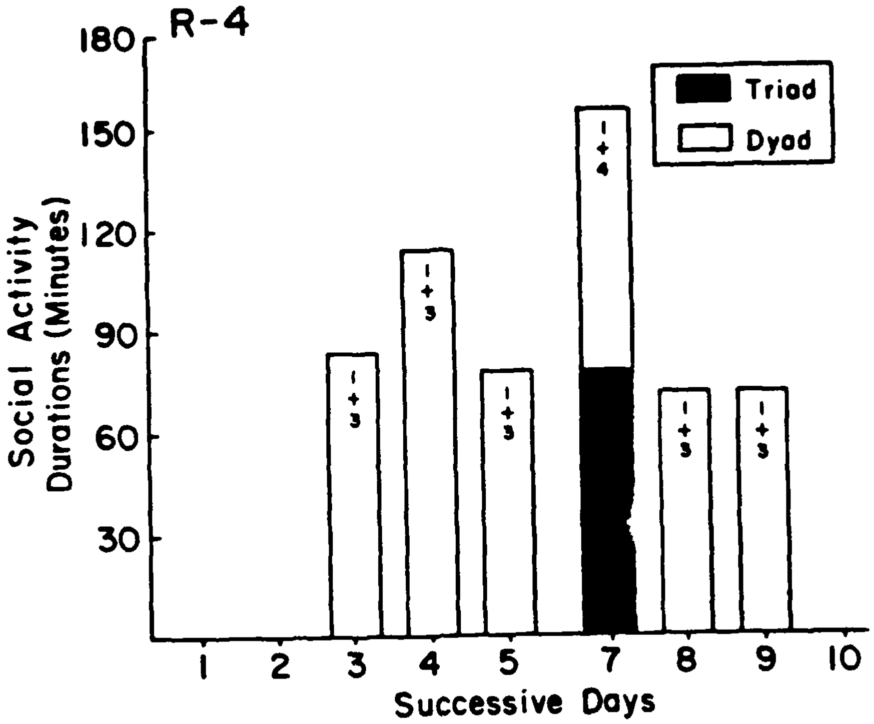


Figure 63. Social activity durations for all subjects in R4 across successive days of the experiment. The order of a social episode within a day is indicated by successive ordinal positions above the abscissa. Numbers within open bars denote pair members composing a dyadic episode. Day 6 was a baseline "alone" day.

In R3, the original group showed triadic episodes, all of which lasted at least 1 hour, on 3 of the 5 days. Two briefer dyadic episodes occurred, one on Day 2 and one on Day 3. The reformed group showed a triadic and a dyadic episode on all of Days 7-10. Triadic episodes lasted at least 1 hour, and 3 of the 4 briefer dyadic episodes involved the novitiate, S4.

In R4, a dyadic episode occurred on all of Days 3-5, but no triadic episode occurred. Significantly, these dyadic episodes never involved S2, the "ineffective" team member. When the group was reformed, 1 triadic episode occurred on Day 7, and a dyadic episode occurred on all of Days 7-9. All social episodes lasted at least 1 hour.

Figure 64 presents total urinary testosterone for all subjects within R3 across successive days of the experiment. (A technical problem precluded endocrine analyses for R4.) Although both intersubject and intrasubject variability are present within these data, endocrine responses are most notable for the absence of extreme levels and for the absence of demonstrable changes in relationship to group membership replacement.

In response to the recognition of the importance of the timely sharing of information by verbal communications among team participants to accomplish maximum performance effectiveness on the TMTPB, computer assisted assessment of intermember vocal utterances during operation of the TMTPB was undertaken for R4. Subjects within R4 wore headsets while operating the TMTPB, and all instances of a vocal utterance (i.e., frequency and duration, not content) were stored in a digital format for subsequent analysis.

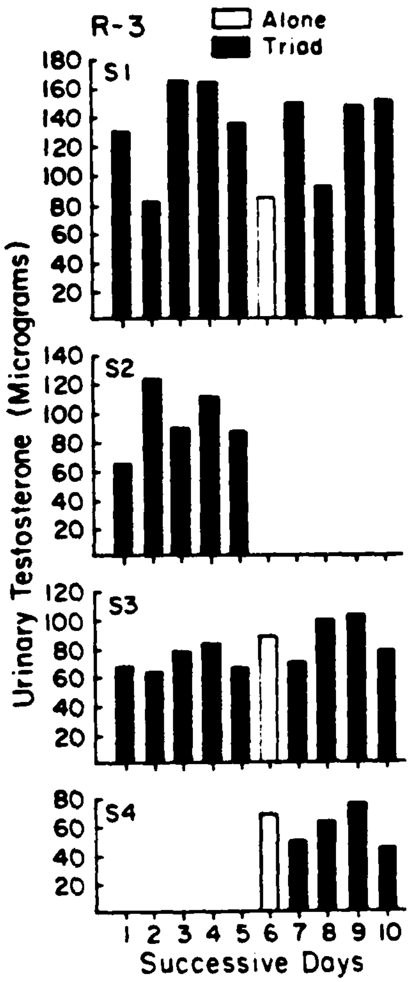


Figure 64. Total urinary testosterone for all subjects in R3 across successive days of the experiment.

Each subject's vocalization series was detected by means of an A to D converter and a PDP8 computer. Vocalization values were sampled 1 per sec, and cumulative time of vocalization onset and offset were stored on disk files. Analyses of durations, pauses, and switching pauses were achieved by direct evaluations of cross correlations of pairs of subjects' vocalization series were achieved by first computing min-by-min total durations of vocalization for each subject. Although time series data do not lend themselves to simple inferential statistical interpretations, the reliability of the following relationships was demonstrated by showing similar outcomes within successive segments of the database.

Figure 65 presents mean vocal utterance duration for all subjects within R4 when the original group operated the TMTPB and when S2 was replaced. Mean utterance durations varied between 1.5 sec (S1, original group) to 2.5 sec (S3, S2 replaced). Subject 1's duration was demonstrably least affected by membership replacement, and S3's duration was demonstrably most affected.

Figure 66 presents mean pause duration for all subjects within R4 when the original group operated the TMTPB and when S2 was replaced. Mean pause durations varied between 6.5 sec (S2, S2 replaced) and 11 sec (S2, original group). Pause duration for the subject identified as "S2" dropped notably when he was replaced by the novitiate participant.

Figure 67 presents mean switching pause duration for all subject pairs within R4 when the original group operated the TMTPB and when S2 was replaced. A switching pause is defined by the time that elapsed between

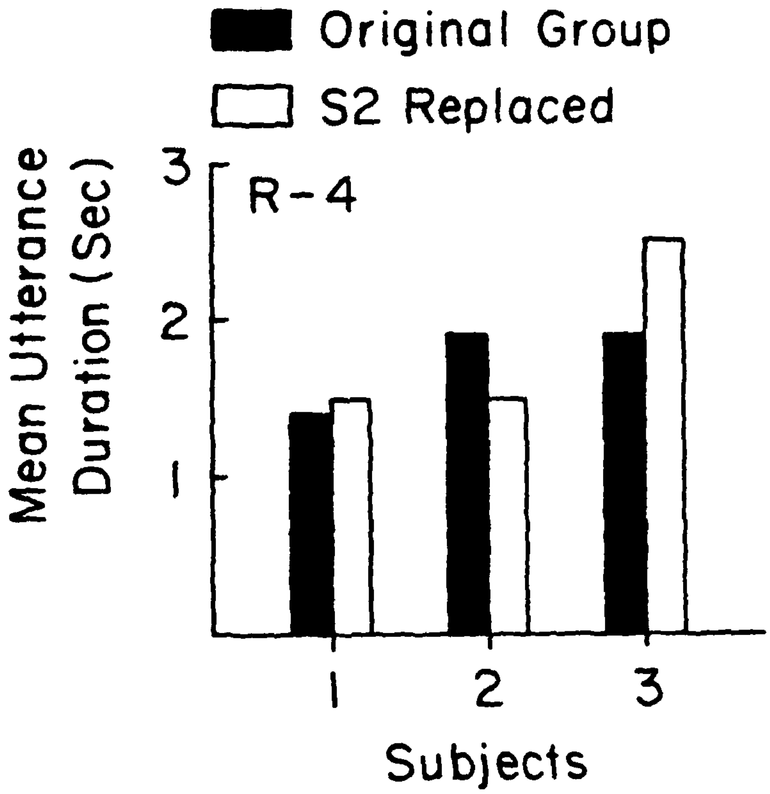


Figure 65. Mean vocal utterance duration for all subjects in R4 when the original group operated the TMTPB and when S2 was replaced.

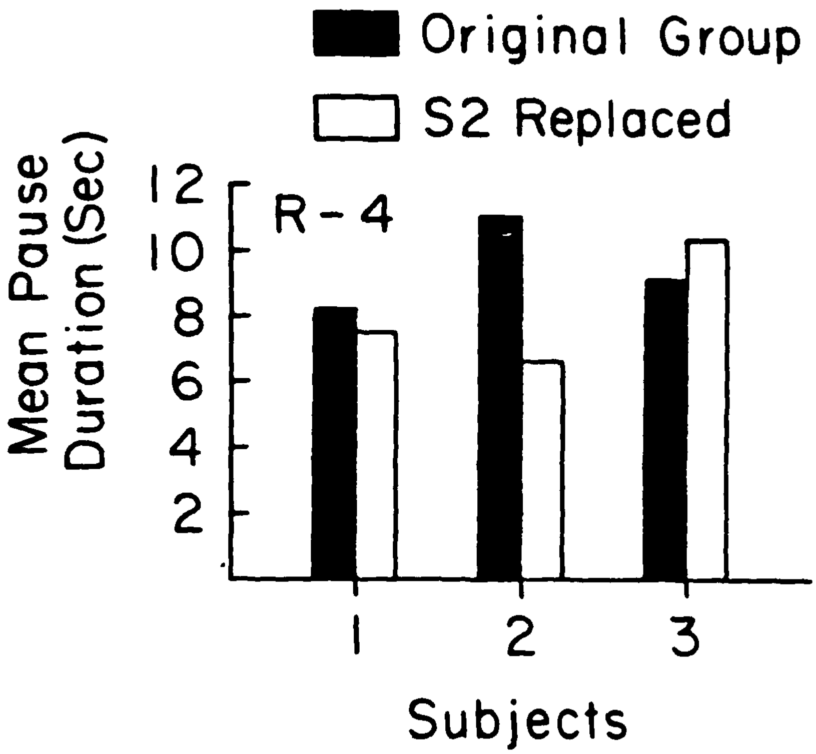


Figure 66. Mean pause duration for all subjects in R4 when the original group operated the TMTPB and when S2 was replaced.

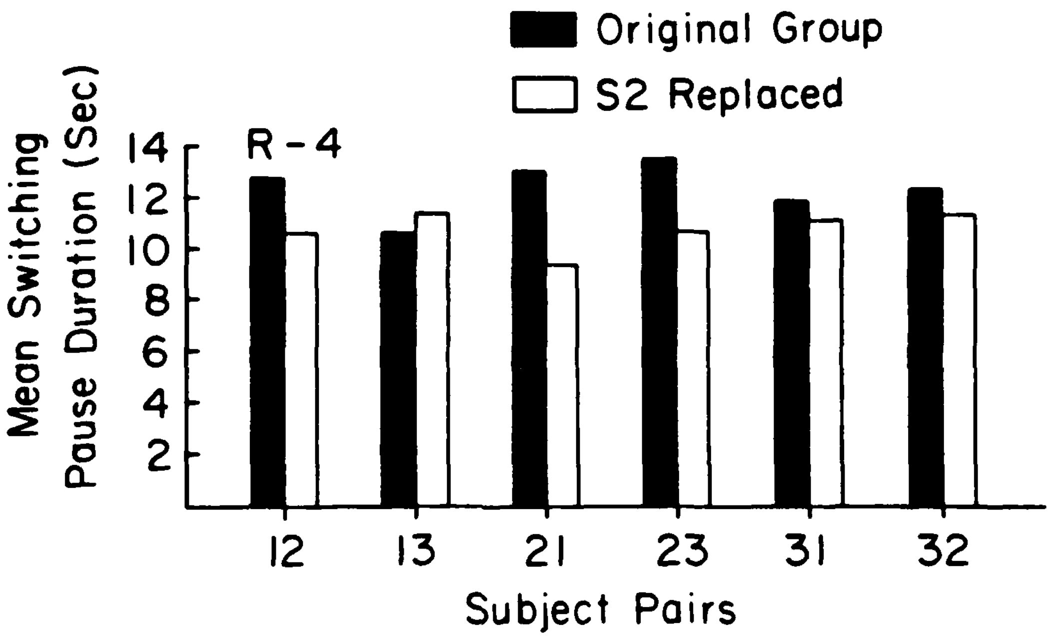


Figure 67. Mean switching pause duration for all subject pairs in R4 when the original group operated the TMTPB and when S2 was replaced.

the end of one subject's utterance and the beginning of the next speaking subject's utterance. Switching pause durations varied between 9 sec (21, S2 replaced) to under 14 sec (23, original group). Switching pause durations were most notably affected among subject pairs that involved S2, who was replaced by a novitiate participant.

Figures 68, 69, and 70, show cross-correlations for lag times of -6 minutes to +6 minutes for mean vocal utterances per minute for all possible subject pairs (12, 23, 13, respectively) in R4 as observed during TMTPB performance. For all 3 subject pairs, the cross-correlation pattern was symmetrical during Days 1-5, with a maximum at lag 0 of approximately 0.4. When S2 was replaced by the novitiate, the cross-correlations between S1 and S2 decreased markedly at all lag values. The cross-correlation pattern between the new subject and S3 became asymetrical, indicating that S2 tended to lead S3 in conversations during Days 6-10. In contrast, the cross-correlation pattern between S1 and S3 is similar for both phases of the study.

These data show the shift in communication patterns that occurred when S2 was replaced by a novitiate participant, and they suggest that initial intermember speech patterns may provide "early warning signs" of a team's inability ultimately to form an effective work group.

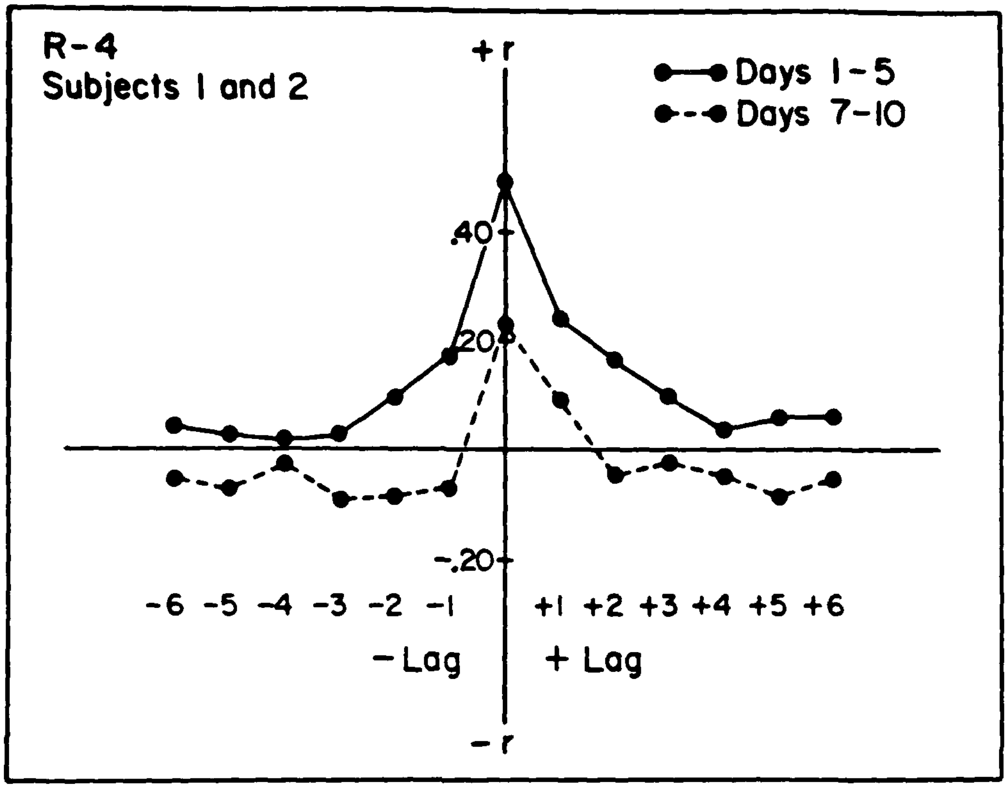


Figure 68. Cross correlations of mean vocal utterances for Subjects 1 and 2 in R4. Lags are in minutes.

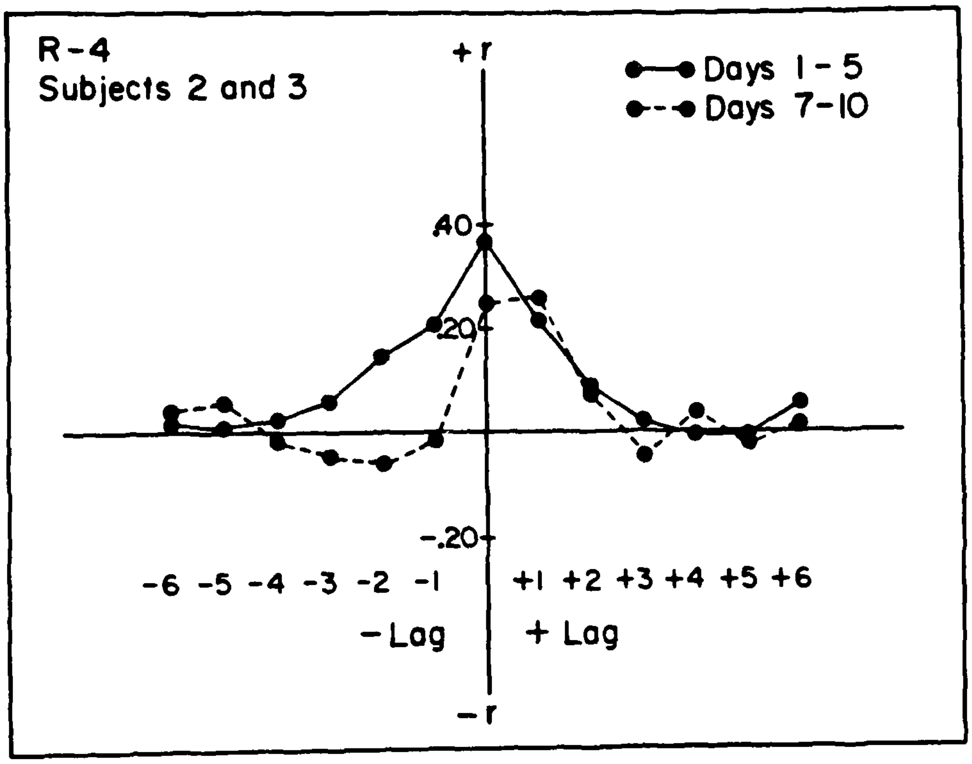


Figure 69. Cross correlations of mean vocal utterances for Subjects 2 and 3 in R4. Lags are in minutes.

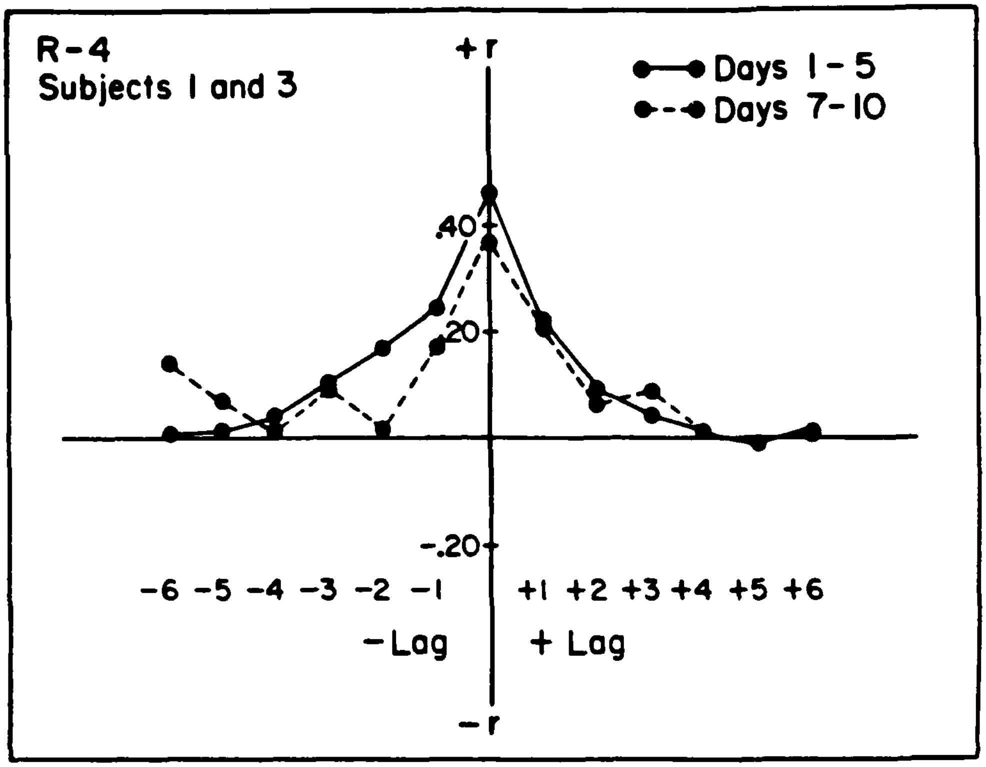


Figure 70. Cross correlations of mean vocal utterances for Subjects 1 and 3 in R4. Lags are in minutes.

DISCUSSION

Groups performing complex tasks under operational conditions can be anticipated to undergo changes in size and membership. Accordingly, the present research project developed a paradigm for investigating effects of such membership turbulence with 2-person and 3-person groups residing in a programmed laboratory environment for 10 successive days. A range of mission parameters (e.g., performance tasks, motivation, group gender composition, social interaction opportunities, etc.) was systematically explored during 10 studies that included 6 analyses of changes in group size and 4 analyses of changes in group membership. The resulting database provides the opportunity for inductive determinations of interrelationships among performance, behavioral, and endocrine effects that were assessed throughout each of the 10 group investigations.

Each of the 10 investigations incrementally contributed to the development of the programmed environment methodology for analyses of individual and group behavior. Each systematic replication demonstrated the effectiveness, generality, and reliability of the behavioral program in generating and measuring complex human behavior repertoires under conditions of isolation and confinement. Having demonstrated the reliability of the MTPB software during the first introduction study, 5 subsequent studies permitted "around the clock" operation of the task. And in the final 2 replacement studies, the reliability of the team TMTPB software was demonstrated as was the sensitivity of the team task to membership replacement effects.

The pattern that groups adopted to operate the performance tasks was almost always established during the initial days of a mission. Work patterns exhibited by a 3-person "introduction" group were almost always similar to the pattern that had been previously established by the dyad. For example, when work periods were initially brief and erratic by the dyad within and across days, (e.g., G-1), similar patterns were observed by the novitiate when he/she joined the group. When work periods were initially brief but somewhat stable in duration (e.g., G5) and initially long but somewhat stable in duration (e.g., G4), similar patterns were also observed when the novitiate joined the group. Similar effects were observed in the "replacement" studies with the exception of R2 whose members showed a dramatic improvement in the regularity of time of day spent working when an original group participant was replaced. These effects indicate the difficulty to be expected when an "ineffective" group history must be overcome to promote high levels of performance effectiveness under both "introduction" and "replacement" conditions. They also suggest that a history of diminutive team performance may be sustained even when an ineffective group participant is replaced by a competent novitiate as was the case in R4.

The introduction of a novitiate into an established group was not observed to occasion reports of significant interpersonal confrontation despite work and sleep schedule adjustments that occurred. In contrast, the replacement of an established participant was associated with an increase in interpersonal friction in R1 and R2 and a decrease in interpersonal friction in R4. In R1, interpersonal friction was reported

by all participants during the second (i.e., replacement) group condition. Significantly in R1, the novitiate preempted the work station on Day 7 in a manner similar to the novitiate in G3 (see Figure 18). In R3 and R4 these interpersonal effects were associated with participants who showed either very high or very low performance effectiveness levels. This suggests that group cohesiveness may be compromised by imposing standards that are excessive or diminutive. It should be emphasized, however, that the importance to mission outcome of high levels of performance effectiveness may outweigh, at least in the short term, the benefits of an interpersonally cohesive group.

The results of these experiments also show that interactive behavioral and biological processes are prominently involved in the individual performance adjustments and social adaptations of small groups in a confined microsociety. Of particular interest in this regard are the findings that implicate the programmed environmental and behavioral interactions in at least those aspects of endocrine regulation reflected in the testosterone measurements. While the previously reported positive relationship between corticosteroid levels and aggressive responses is generally consistent with the "catabolic" influence presumed to be exerted by these hormones on energy metabolism (Emurian, Brady, Meyerhoff, and Mougey, 1983; Mason, 1968), the interactions between androgen levels and both individual and group performance dynamics present a more complex interpretive problem.

The sensitivity of testosterone levels to changes in group size was most evident in those groups in which work routines and/or wake-sleep

schedules were disrupted for some members but remained stable for others. More specifically, success in gaining or maintaining access to a work schedule least disruptive of established wake-sleep routines was sometimes accompanied by elevations in testosterone levels occasioned by changes in the group composition (e.g., S2, Group 3; S3, Group 4). Conversely, decreases in testosterone levels were associated with changes in group composition that occasioned shifts to less than optimal work and/or sleep schedules (e.g., S3, Group 3; S2, Group 4; S3, R1). Significantly, the participants in G5, G6, and R3 showed little or no androgen response to the programmed changes in group composition. For G5, this outcome was consistent with the orderly transition in work routines and the absence of changes in wake-sleep cycles that accompanied the introduction of a new member into this group. In G6, however, no member emerged who clearly and persistently provided direction in structuring the transition between a 2-person and 3-person group, and the members' wake-sleep cycles were erratic. And in R3, the requirements for group coordination on the TMTPB and for schedule cooperation for access to the work station may have overcome interpersonal antagonism that could have been expressed in the endocrine domain.

The suggested interactions between broadly defined "dominance-submission" and "success-failure" relationships and testosterone levels in the present series of studies conform well with the observations reported on changes in group composition and organization in lower primates. Under conditions that involved the introduction of a new rhesus monkey into an existing group, changes in testosterone levels among

high-ranking males were observed to be functionally related to an animal's success (or failure) in defending his status in the primate social order. Victorious animals showed significant increass in testosterone levels (Bernstein, Rose, and Gordon, 1974) while monkeys defeated by the group were reported to show marked androgen level decreases (Rose, Gordon, and Bernstein, 1972). These relationships were further confirmed in experiments that involved the merging of two established groups, with defeated alpha males showing a decrease and victorious alpha males an increase in androgen levels (Bernstein, Rose, Gordon, and Grady, 1979). It must be emphasized, of course, that these studies with laboratory monkeys occurred under conditions that involved intense and enduring aggressive confrontations unlike anything observed in the much more benign exchanges among the humans participating in the present group interaction experiments. But at least one investigation with human subjects has suggested a relationship between plasma testosterone levels and the outcome of physical conflict where winners of a competitive wrestling match showed greater increases in testosterone than losers (Elias, 1981). The general conformity in environmental-endocrinological relationships described under these several investigative circumstances, however, suggests a continuity across species of these fundamental behavioral-biological interaction processes.

The significance of the observed behavioral-biological interactions is to be understood in terms of the completeness of the resulting account of effects of an experiental variable (e.g., the introduction of a novitiate into an established group or the replacement of an established group member

by a novitiate). With regard to the relevance of the interactive endocrinological relationships observed under such conditions, however, it seems reasonable to suggest that the adaptive significance of any hormonal response can best be understood in terms of the consequences of that response at the metabolic level. Although research on the androgens has been largely confined to reproductive functions, it is well established that testosterone has potent "anabolic" properties, promoting protein synthesis in muscle and many other tissues (Dorfman and Shipley, 1956; Kochakian, 1964, 1975) and potentiating some effects of insulin on carbohydrate metabolism (Talaat, Habib, and Habib, 1957). Whether these "anabolic" effects of testosterone and the androgenic metabolites play any appreciable part in general organic or energy metabolism must, of course, await clarification by further investigative analysis. But at the very least, the present experiments emphasize the importance of a multidimensional analysis of the behavioral and biological interactions that determine the adaptations and adjustments of small groups in confined microsocieties.

REFERENCES

Bernstein, I.S., Rose, R.M., and Gordon, T.P. Behavioral and environmental events influencing primate testosterone levels. Journal Evolution, 1974, 3, 517-525.

Bernstein, I.S., Rose, R.M., Gordon, T.P., and Grady, C.L. Agonistic rank, aggression, socal context, and testosterone in male pigtail monkeys. Aggressive Behavior, 1979, 5, 329-339.

Bigelow, G.E., Emurian, H.H., and Brady, J.V. A programmed environment for the experimental analysis of individual and small group behavior. In C.G. Miles (Ed.), Experimentation in Controlled Environments: Its Implications for Economic Behavior and Social Policy Making. Toronto: Alcoholism and Drug Addiction Research Foundation of Ontario, 1975, 133-144.

Brady, J.V., Bigelow, G.E., Emurian, H.H., and Williams, D.M. Design of a programmed environment for the experimental analysis of social behavior. In D.H. Carson (Ed.), Man-Environment Interactions: Evaluations and Applications. 7: Social Ecology, 1975, 187-208.

Chiles, W.D., Alluisi, E.A., and Adams, O.S. Work schedules and performance during confinement. Human Factors, 1968, 10(2), 143-196.

Dorfman, R.I., and Shipley, R.A. Androgens. New York: Wiley, 1956 p. 218.

Eberhart, J.A., Keverne, E.G., and Meller, R.E. Social influences on plasma testosterone levels in male talopoin monkeys. Hormones and

Behavior, 1980, 14, 247-266.

Elias, M. Serum cortisol, testosterone, and testosterone-binding globulin responese to competitive fighting in human males. Aggressive Behavior, 1981, 7, 215-224.

Emurian, H.H. A multiple task performance battery presented on a CRT. JSAS Catalog of Selected Documents in Psychology, 1978, 8, 102.

Emurian, H.H., and Brady, J.V. Small group performance and the effects of contingency management in a programmed environment: A progress report. JSAS Catalog of Selected Documents in Psychology, 1979, 9, 58.

Emurian, H.H., Emurian, C.S., and Brady, J.V. Effects of a pairing contingency on behavior in a three-person programmed environment. Journal of the Experimental Analysis of Behavior, 1978, 29, 319-329.

Emurian, H.H., Emurian, C.S., and Brady, J.V. Appetitive and aversive reinforcement schedule effects on behavior: a systematic replication. Basic and Applied Social Psychology, 1982, 3(1), 39-52.

Emurian, H.H., Brady, J.V., Meyerhoff, J.L., and Mougey, E.H. Positive and negative renforcement effects on behavior in a three-person microsociety. Psychological Documents, in press.

Emurian, H.H., Brady, J.V., Meyerhoff, J.L., and Mougey, E.H. Behavioral and biological interactions with confined microsocieties in a programmed environment. In Grey, J. and Hamden, L.A. (Eds.), Space Manufacturing 4. New York: American Institute of Aeronautics and Astronautics, 1981.

407-421.

Emurian, H.H., Brady, J.V., Meyerhoff, J.L., and Mougey, E.H. Small groups in programmed environments: Behavioral and biological interactions. Pavlovian Journal of Biological Science, 1983, 18(4), 199-210.

Emurian, H.H., Emurian, C.S., Schmier, F.R., and Brady, J.V. Notes on programmed environment research. JSAS Catalog of Selected Documents in Psychology, 1979, 9, 66.

Emurian, H.H., Brady, J.V., Ray, R.L., Meyerhoff, J.L., and Mougey, E.H. Experimental analysis of team performance effectiveness: Methodological developments and research results. Psychological Documents, 1983, 13(1), 15.

Emurian, H.H., Brady, J.V., Ray, R.L., Meyerhoff, J.L., and Mougey, E.H. Experimental analysis of team performance, Naval Research Reviews, in press.

Frankenhauser, M. Psychoneuroendocrine approaches to the study of emotion as related to stress and coping. In R. Dienstbier and R. Howe (Eds.), 1978 Nebraska Symposium on Motivation, Lincoln: University of Nebraska, 1979.

Hare, A.P. Handbook of Small Group Research. New York: Free Press of Glencoe, 1976.

Helmreich, R.L. The Tektite Human Behavior Program. In J.W. Miller, J.T. Van Dewalker, and R.A. Walter (Eds.), Tektite 2: Scientists in the Sea. Government Printing Office, Washington, D.C., VIII, 15-62, 1971.

Helmreich, R.L., Wilhelm, J.A., and Runge, T.E. Psychological consideration in future space missions. In T.S. Cheston and D.L. Winter (Eds.), Human Factors in Outer Space Production. Boulder: Westview Press, 1980.

Kochakian, C.D. Definition of androgens and protein anabolic steroids. Pharmacological Therapeutics B., 1975, 1(2), 149-177.

Kochakian, C.D. Protein anabolic property of androgens. Alabama Journal of Medical Science. 1964, 1, 24.

Mason, J.W. Organization of the multiple endocrine responses to avoidance in the monkey. Psychosomatic Medicine, 1968, 30, 774-790.

Morgan, B.B. and Alluisi, E.A. Synthetic work: Methodology for the assessment of human performance. Perceptual and Motor Skills, 1972, 35, 835-845.

Rose, R.M., Gordon, T.P., and Bernstein, I.S. Plasma testosterone levels in the male rhesus: influences of sexual and social stimuli. Science, 1972, 178, 643-645.

Ray, R.L. and Emurian, H.H. Sustained blood pressure responding during synthetic work. Psychological Record, 1982, 3(1), 19-27.

Ray, R.L., and Emurian, H.H. Repeated eliciatation of the blood pressure response. Physiological Psychology, 1982, 10(3), 321-324.

Scaramella, T.J., and Brown, W.A. Serum testosterone and aggressiveness in

hockey players. Psychosomatic Medicine, 1978, 40, 262-265.

Seitz, C.P., Goldman, D.A., Del Vacchio, R.J., Phillips, C.J., Jessup, R.P., and Fagin, R. Use of the Ben Franklin Submersible as a Space Station Analog. Vol. I, Psychology and Physiology. Grumman Aerospace Corp., Bethpage, New York, 1970.

Sidman, M. Tactics of Scientific Research. New York: Basic Books, 1960.

Smith, S. and Haythorn, W.W. Effects of compatibility, crowding, group size, and leadership seniority on stress, anxiety, hostility, and annoyance in isolated groups. Journal of Personality and Social Psychology, 1972, 22(1), 67-79.

Talaat, M., Habib, Y.A., and Habib, M. The effect of testosterone on the carbohydrate metabolism in normal subjects. Archives of Internal Pharmacodynamics, 1957, 111, 215.

Thorndyke, P.W. and Weiner, M.G. Improving Training and Performance of Navy Teams: A Design for a Research Program. Santa Monica: RAND, 1980.

Turney, J.R. and Cohen, S.L. Defining the Nature of Team Skills in Navy Team Training and Performance. (Final Report N00014-80-C-0811, NR 170-91). Columbia, MD: General Physica Corporation, September, 1981.

DISTRIBUTION LIST

MANDATORY

12 Defense Technical Information Center
ATTN: DTIC: DDA-2
Selection & Preliminary Cataloging Section
Cameron Station
Alexandria, VA 22314

1 Library of Congress
Science & Technology Division
Washington, DC 20540

3 Office of Naval Research
Code 442 OE
800 N. Quincy Street
Arlington, VA 22217

6 Naval Research Laboratory
Code 2627
Washington, DC 20375

1 Office of Naval Research
Director, Technology Programs
Code 200
800 N. Quincy Street
Arlington, VA 22217

ONR Field

Psychologist
ONR Western Regional Office
1030 E. Green Street
Pasadena, CA 91106

NASA

1 Dr. Dewey B. Cramer
NASA Headquarters
Code MFA
600 Independence Ave., S.W.
Washington, DC 20546

1 Dr. Arnauld Nicogossian
Chairman, Scientific Program Committee
Aerospace Medical Association
NASA Headquarters
Code EB-3
Washington, DC 20546

1 Dr. R. Mark Patton
Special Assistant
Office of Director of Life Sciences
NASA Ames Research Center
Moffett Field, CA 94035

OPNAV

1 Deputy Chief of Naval Operations (Manpower, Personnel, & Training)
Head, Research, Development, & Studies Branch (Op-115)
1812 Arlington Annex
Washington, DC 20350

1 Director
Civilian Personnel Division (Op-14)
Department of the Navy
1803 Arlington Annex
Washington, DC 20350

1 Deputy Chief of Naval Operations
(Manpower, Personnel & Training)
Director, Human Resource Management Plans & Policy Branch (Op-150)
Department of the Navy
Washington, DC 20350

1 Chief of Naval Operations
Assistant, Personnel Logistics Planning (Op-987H)
The Pentagon, 5D772
Washington, DC 20350

NAVMAT and NPRDC

1 Program Administrator for
Manpower, Personnel &
Training
MAT 0722
800 N. Quincy Street
Arlington, VA 22217

1 Naval Material Command
Management Training Center
NAVMAT 09M32
Jefferson Plaza, Bldg. 2,
Rm. 150
1421 Jefferson Davis Highway
Arlington, VA 20360

1 Naval Material Command
Director, Productivity
Management Office
MAT-OOK
Crystal Plaza #5
Room 632
Washington, DC 20360

1 Naval Material Command
(MAT-03)
Crystal Plaza #5, Rm. 236
2211 Jefferson Davis Highway
Arlington, VA 20360

4 Naval Personnel R&D Center
Technical Director
Director, Manpower & Personnel
Laboratory, Code 06
Director, System Laboratory,
Code 07
Director, Future Technology,
Code 41
San Diego, CA 92152

BUMED

1 Commanding Officer
Naval Health Research Center
San Diego, CA 92152

1 CDR William S. Maynard
Psychology Department
Naval Regional Medical Center
San Diego, CA 92134

1 Naval Submarine Medical
Research Laboratory
Naval Submarine Base
New London, Box 900
Groton, CT 06349

1 Director, Medical Service Corps
Bureau of Medicine & Surgery
Code 23
Department of the Navy
Washington, DC 20372

1 Naval Aerospace Medical
Research Lab
Naval Air Station
Pensacola, FL 32508

1 Program Manager for Human
Performance (Code 44)
Naval Medical R&D Command
National Naval Medical Center
Bethesda, MD 20014

1 Navy Health Research Center
Technical Director
P.O. Box 85122
San Diego, CA 92138

NAVAL ACADEMY & NAVAL POSTGRADUATE SCHOOL

1 U.S. Naval Academy
Department of Leadership & Law
Annapolis, MD 21402

1 Superintendent
ATTN: Director of Research
Naval Academy, U.S.
Annapolis, MD 21402

HRM

1 Officer in Charge
Human Resource Management
Detachment
Naval Air Station
Alameda, CA 94591

1 Officer in Charge
Human Resource Management
Detachment
Naval Submarine Base New London
P.O. Box 81
Groton, CT 06340

1 Officer in Charge
Human Resource Management
Division
Naval Air Station
Mayport, FL 32228

1 Commanding Officer
Human Resource Management
Center
Pearl Harbor, HI 96860

1 Commander in Chief
Human Resource Management
Division
U.S. Pacific Fleet
Pearl Harbor, HI 96860

1 Officer in Charge
Human Resource Management
Detachment
Naval Base
Charleston, SC 29408

1 Commanding Officer
Human Resource Management
School
Naval Air Station Memphis (96)
Millington, TN 38054

1 Human Resource Management
School
Naval Air Station Memphis (96)
Millington, TN 38054

1 Commanding Officer
Human Resource Management
Center
1300 Wilson Boulevard
Arlington, VA 22209

1 Commanding Officer
Human Resource Management
Center
5621-23 Tidewater Drive
Norfolk, VA 23511

1 Commander in Chief
Human Resource Management
Division
U.S. Atlantic Fleet
Norfolk, VA 23511

1 Officer in Charge
Human Resource Management
Detachment
Naval Air Station Whidbey
Island
Oak Harbor, WA 98278

1 Commanding Officer
Human Resource Management
Center
Box 23
FPO New York 09510

1 Commander in Chief
Human Resource Management
Division
U.S. Naval Force Europe
FPO New York 09510

1 Officer in Charge
Human Resource Management
Detachment
Box 60
FPO San Francisco 96651

1 Officer in Charge
Human Resource Management
Detachment
COMNAVFORJAPAN
FPO Seattle 98762

NAVY MISCELLANEOUS

2 Naval Military Personnel
Command
HRM Department (NMPC-6)
Washington, DC 20350

1 Naval Training Analysis
& Evaluation Group
Orlando, FL 32813

1 Commanding Officer
ATTN: TIC, Bldg, 2068
Naval Training Equipment Center
Orlando, FL 32813

1 Chief of Naval Education &
Training (N-5)
Director, Research Development,
Test, & Evaluation
Naval Air Station
Pensacola, FL 32508

1 Chief of Naval Technical
Training
Code 017
NAS Memphis (75)
Millington, TN 38054

1 Navy Recruiting Command
Head, Research & Analysis
Branch
Code 434, Room 8001
801 North Randolph Street
Arlington, VA 22203

1 Navy Recruiting Command
Head, Research ana Analysis
Branch
Code 434, Room 8001
801 North Randolph Street
Arlington, VA 23607

1 Navy Recruiting Command
Director, Recruiting
Code 40
801 North Randolph Street
Arlington, VA 22203

1 Naval Weapons Center
Code 094
China Lake, CA 93555

1 Jesse Orlansky
Institute for Defense
Analyses
1801 North Beauregard
Street
Alexandria, VA 22311

USMC

1 Headquarters, U.S. Marine Corps
Code MPI-20
Washington, DC 20380

1 Headquarters, U.S. Marine Corps
Code RD-1
Washington, DC 20380

1 Education Advisor
Education Center (E031)
MCDEC
Quantico, VA 22134

1 Commanding Officer
Education Center (E031)
MCDEC
Quantico, VA 22134

1 Commanding Officer
U.S. Marine Corps
Command & Staff College
Quantico, VA 22134

OTHER FEDERAL GOVERNMENT

1 Defense Advanced Research
Projects Agency
Director, Cybernetics
Technology Office
1400 Wilson Blvd., Rm. 625
Arlington, VA 22209

1 Dr. Douglas Hunter
Defense Intelligence School
Washington, DC 20374

1 Dr. Brian Usilaner
GAO
Washington, DC 20548

1 National Institute of Education
EOLC/SMO
1200 19th Street, N.W.
Washington, DC 20208

1 National Institute of Mental Health
Division of Extramural Research Programs
5600 Fishers Lane
Rockville, MD 20852

1 National Institute of Mental Health
Minority Group Mental Health Programs, Rm. 7 - 102
5600 Fishers Lane
Rockville, MD 20852

1 Office of Personnel Management
Office of Planning & Evaluation
Research Management Division
1900 E Street, N.W.
Washington, DC 20415

1 Chief, Psychological Research Branch
U.S. Coast Guard (G-P-1/2/TP42)
Washington, DC 20593

1 Social & Developmental Psychology Program
National Science Foundation
Washington, DC 20550

1 Dr. Earl Potter
U.S. Coast Guard Academy
New London, CT 06320

1 Division of Industrial Science & Technological Innovation
Productivity Improvement Research
National Science Foucation
Washington, D.C. 20550

1 Douglas B. Blackburn, Director
National Defense University
Mobilization Concepts Development Center
Wasnington, D.C. 20319

ARMY

1 Headquarters, FORSCOM
ATTN: AFPR-HR
Ft. McPherson, GA 30330

1 Army Research Institute
Field Unit - Leavenworth
P.O. Box 3122
Fort Leavenworth, KS 66027

3 Technical Director
Army Research Institute
5001 Eisenhower Avenue
Alexandria, VA 22333

3 Walter Reed Army Medical Center
Attn: Dr. Mary Lozano
W.R. Army Institute of Research
Division of Neuropsychiatry
Forest Glen
Washington, D.C. 20012

AIR FORCE

1 Air University Library/ LSE 76-443
Maxwell AFB, AL 36112

1 Head, Department of Behavioral Science & Leadership
U.S. Air Force Academy, CO 80840

1 MAJ Robert Gregory
USAFA/DFBL
U.S. Air Force Academy, CO 80840

1 AFOSR/NL (Dr. Fregly)
Bldg. 410
Bolling AFB
Washington, D.C. 20332

1 Technical Director (AFHRL/MO(T)
Brooks AFB
San Antonio, TX 78235

1 AFOSR/NL
Building 410
Bolling AFB
Washington, D.C. 20332

1 Department of the Air Force
HQUSAF/MPXHL
Pentagon
Washington, D.C. 20330

1 AFMPC/MPCYPR
Randolph AFB, TX 78150

MISCELLANEOUS

1 Australian Embassy
Office of the Air Attache (S3B)
1601 Massachusetts Avenue, N.W.
Washington, DC 20036

1 British Embassy
Scientific Information Officer
Rm. 509
3100 Massachusetts Avenue, N.W.
Washington, DC 20008

1 Canadian Defense Liaison Staff, Washington
ATTN: CDRD
2450 Massachusetts Avenue, N.W.
Washington, DC 20008

1 Commandant, Royal Military College of Canada
ATTN: Department of Military Leadership and Management
Kingston, Ontario
CANADA K7L 2W3

1 National Defense Headquarters
ATTN: DPAR
Ottawa, Ontario
CANAD K1A OK2

1 Mr. Luigi Petrullo
2431 North Edgewood Street
Arlington, VA 22207

1 Dr. Kenneth Martinez
P.O. Box 824
Lawrence, Kansas

CURRENT CONTRACTORS

1 Dr. Richard D. Arvey
University of Houston
Department of Psychology
Houston, TX 77004

1 Dr. Clayton P. Alderfer
Yale University
School of Organization and Management
New Haven, Connecticut 06520

1 Dr. Janet L. Barnes-Farrell
Department of Psychology
University of Hawaii
2430 Campus Road
Honolulu, HI 96822

1 Dr. Gary Bowen
SRA Corporation
800 18th Street, N.W.
Washington, DC 20006

1 Dr. Jomills Braddock
Johns Hopkins University
Center for the Social Organization of Schools
3505 N. Charles Street
Baltimore, MD 21218

1 Jeanne M. Brett
Northwestern University
Graduate School of Management
2001 Sheridan Road
Evanston, IL 60201

1 Dr. Terry Connolly
Georgia Institute of Technology
School of Industrial & Systems Engineering
Atlanta, GA 30332

1 Dr. Richard Daft
Texas A&M University
Department of Management
College Station, TX 77843

1 Dr. Randy Dunham
University of Wisconsin
Graduate School of Business
Madison, WI 53706

1 Dr. Henry H. Emurian
The Johns Hopkins University School of Medicine
Department of Psychiatry and Behavioral Science
Baltimore, MD 21205

1 Dr. Arthur Gerstenfeld
University Faculty Associates
710 Commonwealth Avenue
Newton, MA 02159

1 Dr. J. Richard Hackman
School of Organization and Management
Box 1A, Yale University
New Haven, CT 06520

1 Dr. Wayne Holder
American Humane Association
P.O. Box 1266
Denver, CO 80201

1 Dr. Daniel Ilgen
Department of Psychology
Michigan State University
East Lansing, MI 48824

1 Dr. Lawrence R. James
School of Psychology
Georgia Institute of Technology
Atlanta, GA 30332

1 Dr. David Johnson
Professor, Educational Psychology
178 Pillsbury Drive, S.E.
University of Minnesota
Minneapolis, MN 55455

1 Dr. F. Craig Johnson
Department of Educational Research
Florida State University
Tallahassee, FL 32306

1 Dr. Dan Landis
Department of Psychology
Purdue University
Indianapolis, IN 46205

1 Dr. Frank J. Landy
The Pennsylvania State University
Department of Psychology
417 Bruce V. Moore Building
University Park, PA 16802

1 Dr. Bibb Latane
The University of North Carolina at Chapel Hill
Manning Hall 026A
Chapel Hill, NC 27514

1 Dr. Edward E. Lawler
University of Southern California
Graduate School of Business Administration
Los Angeles, CA 90007

1 Dr. William H. Mobley
College of Business Administration
Texas A&M University
College Station, TX 77843

1 Dr. Lynn Oppenheim
Wharton Applied Research Center
University of Pennsylvania
Philadelphia, PA 19104

END

DATE
FILMED

7-84

DTIC